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**ANALYSIS AND DESIGN OF A
DECISION SUPPORT SYSTEM FOR
SILAS B. HAYS ARMY COMMUNITY HOSPITAL**

by

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Upper-level managers at Silas B. Hays Army Community Hospital ~~(SBHACH)~~, Fort Ord, CA, are tasked with the administrative operation of a Medical Treatment Facility providing various health-care services to the surrounding military community. This broad mission requires hospital administrators to analyze large amounts of data when commonly tasked with solving ill-structured problems resulting from managing such a large hospital. The thesis research presents the use of a Decision Support System (DSS) to support upper-level managers faced with ill-structured problems and discusses the use of structured interviews in deriving the resource manager's critical information needs. These Critical Success Factors ~~(CSFs)~~ are presented in detail and proposed measures that a DSS should possess to satisfy these critical information needs are identified. The design of the first iteration of the Resource Management DSS using structured software design tools provides the necessary documentation from which the system may be implemented. Keywords: theses, System analysis. (KR)

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Analysis and Design of a Decision Support System for Silas B. Hays Army Community Hospital

by

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ABSTRACT

Upper-level managers at Silas B. Hays Army Community Hospital (SBHACH), Fort Ord, CA, are tasked with the administrative operation of a Medical Treatment Facility providing various health-care services to the surrounding military community. This broad mission requires hospital administrators to analyze large amounts of data when commonly tasked with solving ill-structured problems resulting from managing such a large hospital. The thesis research presents the use of a Decision Support System (DSS) to support upper-level managers faced with ill-structured problems and discusses the use of structured interviews in deriving the resource manager's critical information needs. These Critical Success Factors (CSFs) are presented in detail and proposed measures that a DSS should possess to satisfy these critical information needs are identified. The design of the first iteration of the Resource Management DSS using structured software design tools provides the necessary documentation from which the system may be implemented.

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LIST OF ABBREVIATIONS

AQCESS	Automated Quality of Care Evaluation Support System
ARC	Attached Resources Computer
CHAMPUS	Civilian Health And Medical Program of the Uniformed Services
CSF	Critical Success Factor
DD	Data Dictionary
DFD	Data Flow Diagram
DOD	Department of Defense
DSS	Decision Support System
HSC	Health Services Command
MCCU	Medical Care Composite Unit
MIS	Management Information System
MTF	Medical Treatment Facility
PRIMUS	Primary Care to Uniformed Services
SBHACH	Silas B. Hays Army Community Hospital
SDLC	Systems Development Life Cycle
SIDPERS	Standard Installation Divisional Personnel System
UCAPERS	Uniform Chart of Accounts Performance Expenditures Reporting System

I. INTRODUCTION

A. BACKGROUND

1. General Mission of U. S. Army Health-Care Services

Like any precious resource in the Department of Defense (DOD), medical health-care services are regarded as finite and subject to budgetary limitations. Within the U. S. Army, commanding officers of Medical Treatment Facilities (MTFs) are assigned the responsibility for administration of patients under their jurisdiction. The MTF commanding officer is specifically tasked with providing the best possible health care for each patient, ensuring such care is consistent with professional health-care procedures and standards [Army Reg 40-3 85].

This broad mission, coupled with fluctuating expertise levels of health-care providers and scarce resources, compounds an already difficult task of managing a MTF. The Silas B. Hays Army Community Hospital (SBHACH), Fort Ord, California, is no exception. The commanding officer and his staff are tasked with managing the daily operation of the MTF by providing professional medical health-care services to different levels of DOD personnel, all without exceeding annual budget funding. Compliance with this goal is difficult, requiring the analysis of large amounts of information.

2. Need for Information Management

Resource managers at SBHACH draw data from several in-place Management Information Systems (MIS) to support decision making. Unfortunately in most cases, extracted data from an existing MIS is not readily useable. Often the data must be combined with other MIS outputs and put into a recognizable format for management use. For example, to find the average cost the hospital incurs per outpatient visit over a period of time requires data from one MIS providing total outpatients treated, and data from a second

MIS providing total cost spent on outpatients. This data is then combined into a useful ratio for SBHACH resource managers. However, extracting and correlating data into useful information often administratively overburdens managers. Personnel tasked with extraction and correlation tasks sometimes duplicate effort, repeat the same procedures done for earlier periods, and may provide varying results even though they use the same data. There is a need for a system that provides a systematic, structured approach to satisfy management information needs.

A Decision Support System (DSS) specifically developed for SBHACH resource managers will provide this structured approach by supplying on request timely and consistent information, which is extracted and correlated without undue administrative burden.

B. INTRODUCTION TO DECISION SUPPORT SYSTEMS (DSS)

A DSS is a computer-based, interactive system that aids decision makers in confronting ill-structured problems through the use of data and analysis [Sprague 82]. The role of a DSS is to provide necessary information in a useable format, on time, to the decision maker who needs it. In this context, a properly designed DSS for SBHACH will support decision makers by satisfying information needs. The DSS on demand will tie into existing MIS, extract necessary data, combine this data with other outputs into a meaningful form, and present the information to decision makers in a timely manner.

A theoretical framework for DSS is developed in Chapter II. In this chapter, the reader will be familiarized with the general characteristics of a DSS, planning and building a DSS, management role in developing a DSS, and other DSS concepts important to the research. Where appropriate, specific applications from the theoretical understanding of a DSS to the actual case at SBHACH are made. The purpose of moving between theory and practical application is to demonstrate the direction of research followed in analyzing and designing the DSS for SBHACH.

C. METHODOLOGY AND OBJECTIVES OF RESEARCH

In order to properly conduct the analysis and design of a DSS for SBHACH, a structured approach was used to elicit management information needs, analyze current information systems, and design the proposed DSS. Critical Success Factor (CSF) interviews were conducted to identify information needs, existing MIS were studied for use by the delivered product, and a structured design methodology was implemented in designing the proposed DSS.

1. Research Questions

The following research questions were developed in order to fulfill the goal of this thesis as a document from which a useful DSS may be implemented:

- How should one best determine Critical Success Factors for a large hospital, specifically Silas B. Hays Army Community Hospital (SBHACH), Fort Ord, California?
- What are the Critical Success Factors for SBHACH?
- What should a Decision Support System look like in order to support decision makers in meeting these Critical Success Factors?
- What must be done to build such a Decision Support System?

By thoroughly researching these questions and presenting the answers in a concise form, the goals of this thesis will be satisfied.

2. Critical Success Factors (CSFs)

Chief executives are finding more and more that they are inundated with data in an unusable form. Managers examine reports, determine what pieces of information are important, and take the necessary action [Rockart 79]. The same is true for upper-level management at SBHACH [Appendix A]. The information required to make timely decisions is present in existing MIS, but not in useable form to make decisions based solely on a single MIS output. The most difficult part of analyzing management information needs is eliciting what "key areas" of business activity are necessary to obtain good results for a

manager to reach established goals [Rockart 82]. These "key areas" are called Critical Success Factors (CSFs) and are a major concern for decision makers in order to perform well, regardless of the industry in which they operate.

Critical Success Factors are used to generally describe what managers need to be concerned with in their daily business functions. A more precise definition of CSFs is found in Bullen and Rockart's article "A Primer on Critical Success Factors," defining CSFs as:

> The limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department, or organization. CSFs are those key areas where "things must go right" for the business to flourish and for the manager's goals to be attained [Bullen 81].

Managers may not be able to explicitly state exactly what their CSFs are, but they know or have a feeling for the information they require in order to satisfy these CSFs. Most managers have implicit CSFs that they have been using without consciously knowing it to help them manage. By using a structured interview technique, implicit CSFs are made explicit [Bullen 81].

The author conducted a series of structured interviews of upper-level management at SBHACH using Appendix B as a guide. Synopses of interviews are contained in Appendix C, and from these interviews CSF information needs were determined for development into a DSS. Chapter III provides a detailed analysis of CSF development.

3. Existing Hospital MIS

A DSS will draw upon existing MIS that have already been developed in order to support identified information needs. After information requirements are presented, a synopsis of in-place MIS is discussed to identify where data may be obtained to satisfy user needs.

SBHACH has in place approximately five different stand-alone MIS. During the course of research it was necessary to study the existing MIS to determine what

information is collected and the form it is in. This research was done through interviews of information systems personnel at SBHACH (summarized in Appendix D) and MIS documentation studies. Chapter III also provides a detailed analysis of this portion of the research.

4. Structured Analysis and Structured Design Methodology

Structured Analysis and Structured Design use a systematic approach to develop a software product that is maintainable, reliable, and adaptable [Page-Jones 80]. By using the tools of this methodology, this thesis produces a properly documented software product from which a working DSS may easily be implemented.

Once CSF data were obtained, outputs from Structured Analysis and Structured Design methodologies were developed and presented in Chapter IV. The deliverables from this method—Data Flow Diagrams (DFDs), Data Dictionaries (DDs), structure charts, mini-specifications, and module specifications—are presented in the appendices as documentation for the DSS. These outputs will allow information systems personnel to easily implement the designed DSS.

The different stand-alone MIS at SBHACH run on different and sometimes incompatible hardware. The programs are written in different programming languages and supported by civilian contract personnel. Integration of software modules developed by SBHACH personnel into the different stand-alone systems to extract data was ruled out due to possible violation of existing commercial contracts. Chapter IV describes the approach taken to remove needed data from the different MIS to support the designed DSS.

D. ASSUMPTIONS AND LIMITATIONS OF RESEARCH

The scope of the thesis was limited in size to accommodate an adequate amount of proposed measures to satisfy CSFs and still provide a useful product. The proposed measures incorporated into the DSS were limited to a manageable number for a single thesis

student to adequately develop. Adding to the size of the DSS by follow-on research is discussed in the final chapter.

Implementation was not considered an overall goal. A thorough analysis of design effort first must be completed. Further, SBHACH information systems personnel are better qualified to choose the programming language with which they wish to implement the developed DSS. If they code the DSS, they will more easily maintain the final product for future use due to familiarity developed during the implementation phase.

E. BENEFITS OF RESEARCH

The delivered product will provide documentation from which a DSS may be implemented. Once the DSS is implemented, it will provide a significant increase in relevant information flow to managers who need it. This system will quickly extract needed data and manipulate it into a useable form for presentation to decision makers. This aspect of the system itself will eliminate the inordinate amount of time expended on hand extraction of data and consolidation of numerous disjointed reports.

Follow-on research is suggested in the area of aiding information systems personnel in implementing the delivered product. A large amount of coding and testing will be required before the DSS is implemented. Another area of research to be explored is the continuation of CSF interviews and adding to the breadth of the DSS by satisfying more information needs.

F. ORGANIZATION OF THESIS

In this chapter, a brief introduction to the background of the thesis and the methodology and objectives of the research were presented. The reader was introduced to the CSF interview technique to elicit information needs from management personnel at SBHACH

and the proposed implementation of the delivered product by information systems personnel.

Chapter II establishes a theoretical framework from which the DSS is developed. Chapter II familiarizes the reader with the characteristics and purpose of a DSS, management's role in developing and justifying a DSS, planning and building a DSS, and DSS architecture theory.

Chapters III and IV present the detailed analysis and design of the SBHACH DSS. Chapter III describes the interviews used to analyze information needs of upper-level management. The CSFs are prioritized in this chapter and existing MIS details and computer resources are presented in detail. Chapter IV provides the transformation of the analysis conducted to the software design of the actual DSS. The outputs of the Structured Analysis and Structured Design method are formally presented from the appendices resulting in the documentation of the DSS. Finally, Chapter V summarizes the research conducted and provides suggestions for the implementation phase of the delivered product.

II. DEVELOPING A THEORETICAL FOUNDATION OF DECISION SUPPORT AND DECISION SUPPORT SYSTEMS

In recent years, there have been significant developments in the Decision Support Systems (DSS) field. A review of pertinent literature provides various definitions of what DSS are and how decision support can aid decision makers. In this chapter, a relevant framework is developed from publications by respected DSS researchers. Where appropriate in the framework presentation, a bridge between theory and the proposed DSS at Silas B. Hays Army Community Hospital (SBHACH) will be made.

Most of the publications read offered varied characteristics of decision support and DSS. The next section presents characteristics of DSS deemed most relevant.

A. DSS CHARACTERISTICS

Decision support is looked upon as an approach to analyzing complex organizational decision making and the ways decision making can be aided through computer technology. In this section, general definitions and DSS purpose are presented, the level of management supported by a DSS is discussed, and the relationship of Management Information System (MIS) technology to decision support is identified. This provides the reader with a better understanding of the philosophy behind decision support and the ways it can aid organizational decision making.

1. DSS Definition and Purpose

Any discussion about DSS should start with the differences in terminology between a DSS and a "decision support system." Huber explains that each individual has a personal decision support system, a "dss," which is used daily in organizational decision making. This system uses various methods to collect and categorize relevant data and uses

decision aids to examine possible outcomes of alternatives analyzed. In essence, managers use a variety of resources to ask "What if?" questions to decide on a particular problem solution. A Decision Support System (DSS) is that part of the personal decision support system, a "dss," that is automated or computer enhanced [Huber 81]. A difference in terminology is made here. A "dss" does not have to be automated by computer technology, but a DSS takes advantage of the processing and modeling power of computer technology.

Keen summarizes that an important goal of a DSS is for decision makers to learn more about the decision problem and a DSS is suited to provide this learning environment [Keen 87]. From this summary, a DSS can be described as a computer-enhanced management learning tool that aids decision makers in defining the decision problem and analyzing possible alternatives.

A broad definition of a DSS is provided by Sprague and Carlson in their book [Sprague 82]. They define DSS as having the following characteristics:

- Computer based systems;
- That help decision makers;
- Confront ill-structured problems;
- Through direct interaction;
- With data and analysis.

This general definition provides a useful "checklist" with which a DSS for SBHACH may be evaluated in later chapters.

Ford presents a DSS as incorporating features from management information systems, management science, and operations research technologies into a system that draws upon all technologies for a synergistic effect [Ford 85]. This synergistic whole of man and computer is much greater than the sum of the parts—man and computer performing decision making separately. An interactive computer-based system accessing data

databases and allowing decision makers to perform "What if?" analysis will achieve desired synergy.

A 1981 study of eight commercial DSS by Keen showed that different DSS applications have many common characteristics but all should have four features to be successful [Keen 81]. As a minimum, a DSS should be the following:

- Flexible to handle different situations;
- Easy to use;
- Responsive;
- Communicative.

These four factors were important to consider when developing a DSS for SBHACH because ignoring any one of these factors might cause the product to lapse into disuse. The delivered product when implemented should address several identified critical problems. The DSS should be easy to use for novices as well as experienced computer users; to encourage use, the DSS should also feature a user dialog responsive to user queries.

This section explicitly points out that DSS are developed to aid managers in their decision making tasks. The question arises then whether DSS should be available for all managers within an organization, or whether DSS should be built for a specific organizational management level. The next section addresses this question about which managers within an organization a DSS should support.

2. Level of Management Supported By a DSS

Ackoff explains that a DSS tends to be used for semi-structured and ill-structured problems. He points out that these less-structured problems are commonly faced by upper-level managers [Ackoff 67]. Lower-level managers deal with more structured problems that have known solutions and thereby make a DSS difficult to cost justify.

Alexander echoes the level of management supported by pointing out that a DSS should provide relevant, boiled-down data to senior managers or, simply, high-level information for high-level people [Alexander 86]. Sprague states that upper-level managers usually deal with less structured problems and a DSS can provide needed information for decision making [Sprague 86].

The proposed DSS is intended for use by senior resource managers at SBHACH. The DSS will provide these upper-level mangers with relevant information to address the ill-structured problems they face. Chapter III provides more detail in identifying which managers the DSS will support at SBHACH.

3. MIS Versus DSS

A review of the literature brought out some important concepts about the relationship between MIS and DSS technologies. It is important to present an MIS and DSS overview to discuss their interaction with one another, and specifically how MIS can support DSS, differences in the types of management problems supported by each technology, and the separation of decision making and information gathering. These distinctions will be key in defining how the MIS at SBHACH will be used in conjunction with the designed DSS.

a. MIS Support of DSS

Due to the many existing stand-alone MIS at SBHACH, it is necessary to discuss how an MIS is used in relation to a DSS. Alexander proposes that an MIS supports a DSS in that:

> A DSS does not replace or compete with other systems; instead, it extracts from other systems the information that is essential to the process of decision making. [Alexander 86]

Figure 2-1 graphically depicts a DSS acting as an intermediary between user and data sources. The DSS accesses the different MIS, manipulates the data, and

selectively presents the processed information to users. Chapter III provides a specific description of how existing MIS at SBHACH will support the developed DSS.

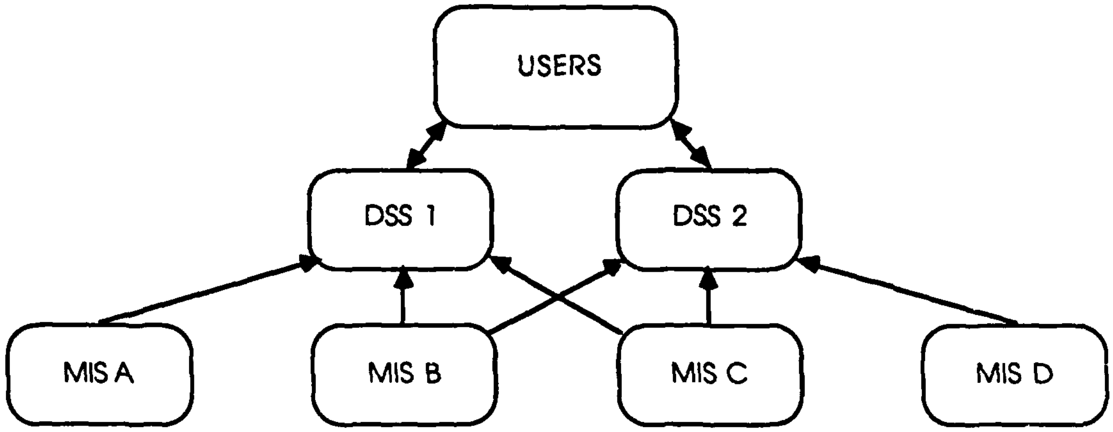


Figure 2-1. **Management Information Systems (MIS) in Relation to Decision Support Systems (DSS)**

As discussed earlier, DSS are used to support upper-level managers confronted by ill-structured problems. This next section differentiates the varied levels of problem structure facing different levels of managers and which technology, MIS or DSS, is best suited for implementation in the different cases.

b. MIS and DSS Problem Structure

MIS and DSS are developed to support different types of management problems within an organization. The different types of problems to be discussed range from structured to unstructured problem areas. Figure 2-2 shows the different levels of problem structures within an organization; inside each cell are types of sample management problems faced by decision makers. These problem types are not always clear cut and tend to be less defined categories [Gorry 71]. According to Gorry and Scott Morton, a nebulous dividing line at the semi-structured decision level can be drawn separating the figure into two areas: structured or unstructured problems. These two areas are not well defined

on the fringes of the separation but represent levels of problem structure tending to be supported by either MIS or DSS applications.

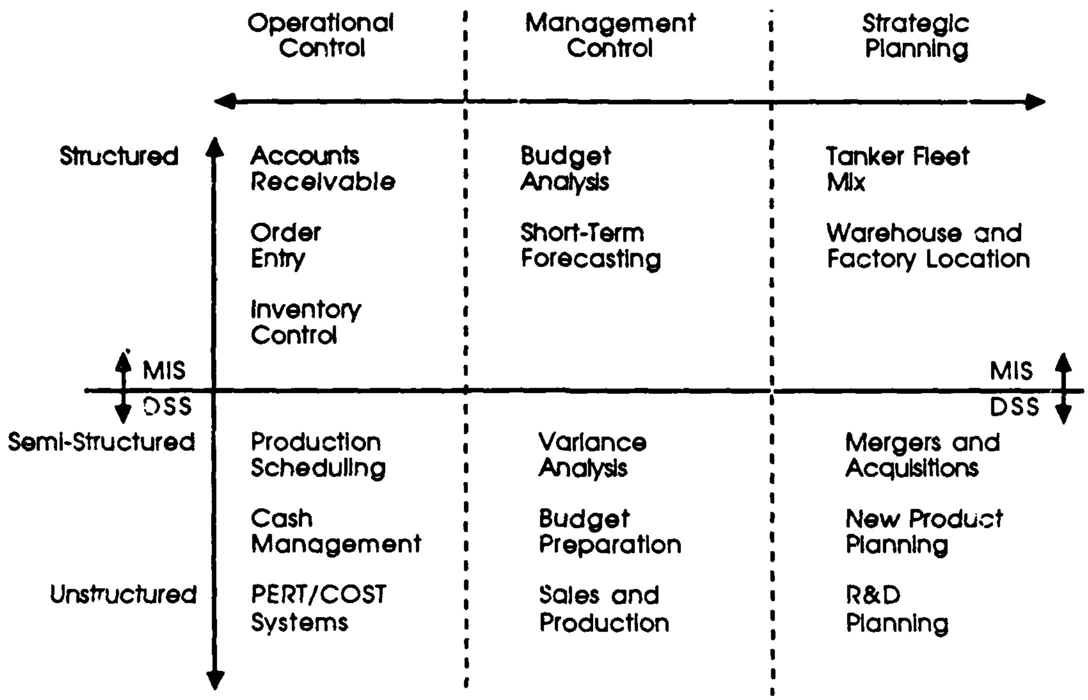


Figure 2-2. **Different Levels of Decision Making Supported by Management Information System (MIS) or Decision Support System (DSS) Technologies**

A management problem is considered structured if it is repetitive, routine, and most of the decision making process may be automated. An unstructured problem is a novel, new problem that has not been faced by managers before [Simon 60]. Structured and unstructured problems differ in their requirements for information and computer support.

The upper half of Figure 2-2 deals with structured problems and information needs for structured problems. Because these problem types have little to do with real information management, they are best satisfied by MIS or data-processing technologies.

The area below the separation contains more complex variables. These unstructured problem areas are best addressed using DSS capabilities [Gorry 71].

In essence, MIS are used to support lower-level managers who deal with more routine or structured decision-making tasks. On the other hand, DSS aid upper-level managers when faced with non-routine or unstructured decision making tasks.

c. *Information Gathering and Decision Making Separation*

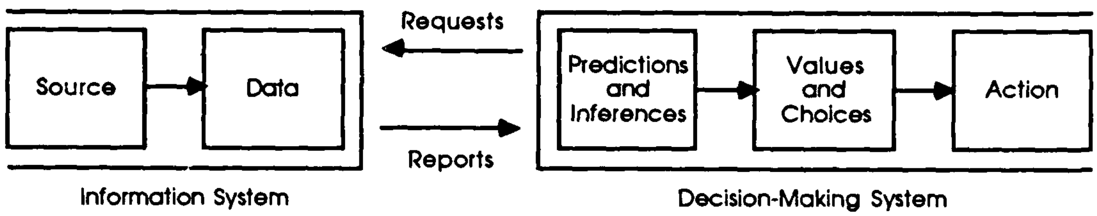
The previous sections discussed the different purposes of MIS and DSS technologies in relation to the level of management supported and the structure of problems addressed. This section provides a differentiation between MIS and DSS in relation to gathering information and decision making.

It is important to define at what point in the decision process an MIS leaves off and a DSS picks up. The decision process is a combination of the information system and the decision-making system. The information system is the process through which data is collected and stored. The decision-making system is the actual person or persons responsible with analyzing the information, analyzing alternatives based on data presented, and choosing an alternative. The entire decision process deals with collecting data from various sources, making predictions and drawing inferences from the data, assigning values from inferences drawn, and taking action. Figure 2-3(a) depicts the sequence of events from data collection to action taking that combine the information and decision-making systems into the decision process [Mason 81].

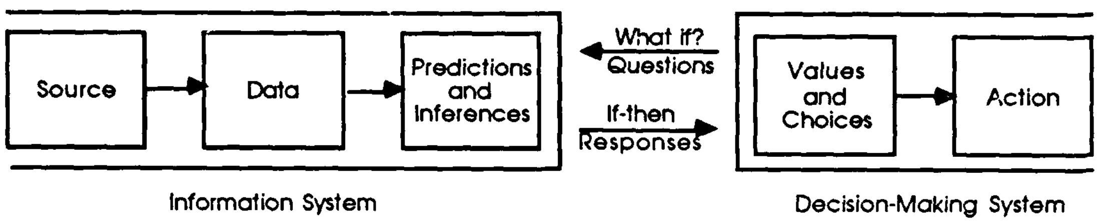
Figure 2-3(b) represents support an MIS lends to the decision process. The information system is tasked with storing, retrieving, and classifying potentially useful data for the decision-making system. The decision-making system then determines from which areas the data must be retrieved and makes these requests to the information system. Mason points out that it is not feasible for the information system to have the capability of

retrieving all combinations and permutations of possible requests. Therefore, the decision system is tasked with generating these requests, drawing inferences and predictions from delivered reports, assigning values, and choosing a course of action. Figure 2-3(b) represents the MIS level of support present at SBHACH.

(a) Decision Process



(b) MIS Support of Decision Process



(c) DSS Support of Decision Process

Figure 2-3. **MIS and DSS Support of Decision Process**

The designed DSS for SBHACH will go a step beyond the MIS level and provide predictive information to decision makers. Figure 2-3(c) combines the ability to make predictions and draw inferences from the data. In this manner, the decision-making

system can ask "What if?" questions and get appropriate, timely responses from the information system. The decision-making system then assigns values to possible choices and takes action. As will be seen in Chapter III, Figure 2-3(c) represents the separation of the information and decision-making systems for the SBHACH DSS.

B. PLANNING AND BUILDING A DSS

So far, definitions of a DSS and how one can support an organization's decision-making process have been provided along with the differences between MIS and DSS technologies. This section will now present different development methods that are used for planning and building DSS.

Historically, the methodology used by systems analysts to develop computer software has been the systems development life cycle (SDLC) process. As a system is conceived and moves from idea conception to implementation, it must pass through several steps. Davis describes a typical SDLC in Figure 2-4 [Davis 83].

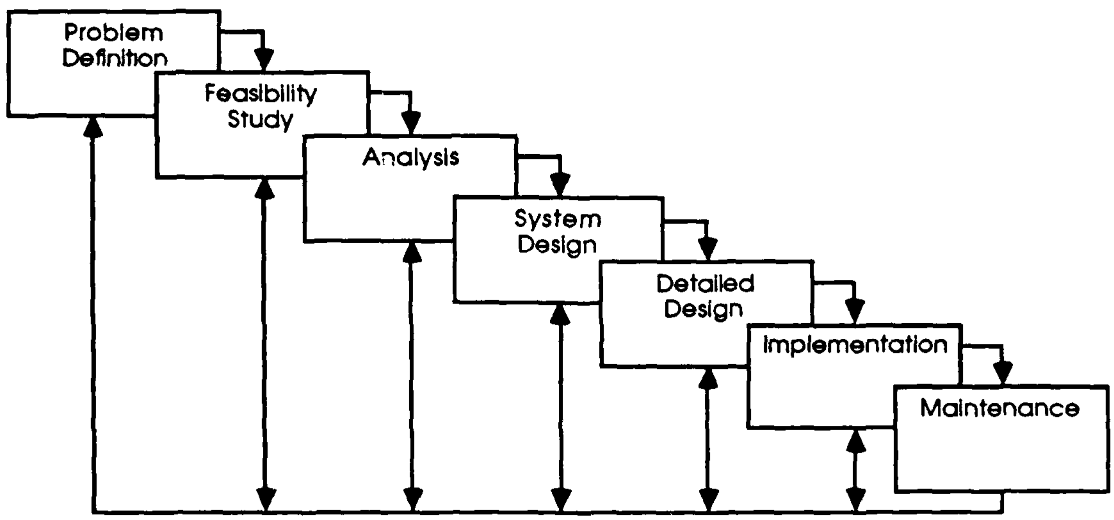


Figure 2-4. **Classic Systems Development Life Cycle Waterfall Model**

When this structured approach is used, an analyst must start with problem definition and methodically progress from one step to the next. As specific requirements for each step are completed, the development moves to the next step, with overlap occurring between steps [Davis 83]. For the most part, specific requirements must be met during each step before system evolution can progress to the next step. This approach of systematically moving through the life cycle, although a disciplined practice for systems development, is not appropriate to the development of a DSS.

A typical system can be developed using the steps in Figure 2-4 because at the beginning of the life cycle, the problem can be isolated by a skilled systems analyst and defined to a degree necessary to begin the remaining steps. Unlike this approach, a DSS cannot be well defined at the beginning. Analysts and designers have difficulty in eliciting management information needs because decision makers cannot define in advance what the system should do. Planning and building a DSS is not just purchasing hardware and developing software to support decision makers. It is planning, designing, and studying the organization's decision making processes [Alexander 86]. There are different methods of studying this decision making process and constructing a DSS, of which two will be presented here.

1. DSS Building Methods

The two DSS building methods presented, though not always distinct, are discussed to develop a flavor for the complex approach of constructing a DSS. The two approaches are the iterative and the adaptive methods. The major similarities and the minor differences of the iterative and adaptive methods are presented to introduce an alternative building method to the SDLC methodology.

a. Iterative Method

The iterative approach to DSS development combines the first several steps in Figure 2-4. It is a building block approach that the DSS builder uses to meet actual

user requirements. A sub-problem is agreed upon between user and developer, a system is designed to satisfy this sub-problem, and the system is presented to the user for feedback. The builder makes necessary corrections and continues the process by building onto the existing system. This loop is repeated several times. As the product is added to and revised, the user is involved with the builder continuously to provide constant feedback [Sprague 80]. Figure 2-5 demonstrates the iterative process between the builder and user.

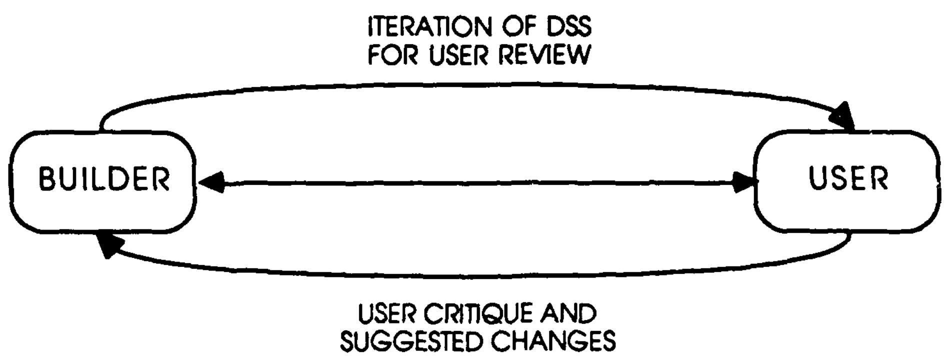


Figure 2-5. **User/Builder Relationship of Iterative Development Method**

The product is never really finished, but the frequency of loops decreases until a useable product finally stabilizes for use. This approach is different from prototyping in that the first deliverable is a useable system and not a test case. The deliverable may not perform all functions the user requires, but it can be iteratively built upon to encompass a great deal of user requirements. The iterative method incorporates the first steps of the SDLC method shown in Figure 2-4 into a large feedback cycle. The concentration is on the link established between the user and the builder. The adaptive method, on the other hand, focuses on three links.

b. Adaptive Method

The adaptive method is very similar to the iterative method in that it also combines several steps of the systems development life cycle method. The adaptive

approach uses feedback from the user to build upon and change the product to user specifications as demonstrated in Figure 2-5, but also incorporates two other links. This adaptive approach focuses on three elements involved in building a DSS as shown in Figure 2-6 and concentrates on the three links between these elements in developing the product [Alavi 84].

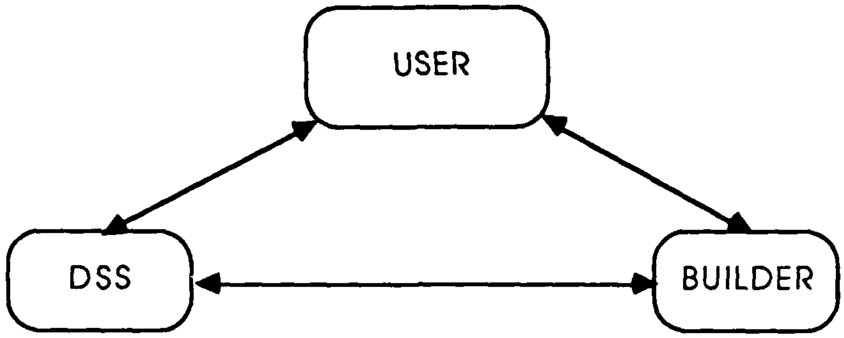


Figure 2-6. **Adaptive Elements of DSS Development**

The user-system link deals with studying the effects a user's characteristics will have on operating the DSS. This area includes user cognitive styles addressed later in this chapter, experience and background of computer use, and user problem-solving techniques. This link is important to make and establishes who will be using the DSS and what their attitudes are towards computing. This link takes into account the dialog existing between user and DSS and the effect it has on the user.

The system-builder link involves the flexibility of system architecture. It allows the addition of features and changes to existing ones to accommodate added capabilities. These changes should be made without undue time and resource expenditures. As a builder understands more of the user's needs and the user understands more of what a DSS can do, incorporating this new knowledge quickly and efficiently into the DSS will further enhance the delivered product.

Finally, the user-builder link is the communication link necessary to develop the DSS. This collaboration allows the user to learn about the power decision support can give to the decision maker and allows the builder to learn about user requirements and build credibility [Alavi 84].

Similar to the iterative method, the builder and user agree upon a sub-problem of user requirements to be incorporated into the DSS. The builder constructs a rough product of the DSS to satisfy this sub-problem and presents the product to the user for review. The difference between the adaptive and iterative methods is the builder's focus on the relationships between builder, user, and system. The adaptive method explicitly studies the unique relationships described above and uses these three links to build the first draft and incorporate user changes.

This section touched upon the level of involvement and importance in the relationship between the user and builder. The next section deals with the important issue of the ways users should be involved in the DSS development and the role managers play in developing DSS falling under their span of control.

C. MANAGEMENT ROLE IN DEVELOPING A DSS

All managers are tasked with monitoring and reviewing projects under their control. A DSS is developed to provide decision support for a specific manager or group, and consequently falls under the control of those supported by the DSS [Hogue 83]. Keen states that a DSS is built from a manager's perspective based on his conception of the decision process and organization [Keen 80]. Therefore, it is important the user/manager is actively and constantly involved in the control and development process of a DSS.

1. User/Management Involvement

Within an organization, usually one person or department recognizes information needs and that a DSS may satisfy these information requirements [Young 84]. Young

points out it is essential that an individual knows a DSS can provide decision support for the organization and the individual is in a management position to power the decision to develop the DSS.

As suggested in the iterative and adaptive design methodologies, the development effort should be a constant feedback loop between user and builder. The user must be involved from inception to delivery to ensure user requirements are satisfactorily met and critical information needs are satisfied [Hogue 84]. A study of 18 DSS by Hogue and Watson revealed that management control by the requesting users was accomplished through user involvement, review of developed products, and documentation [Hogue 83]. Review points were established for the user to review, approve, and document the product as it was submitted iteratively by the builder. As the DSS moves toward completion, users provide a constant source of input and review. It would appear that the more users are actively involved in the DSS development, the more the DSS will be accepted. Users will develop an "ownership" in the DSS and aid in the development effort. User expectations will be managed better in that the user will periodically review DSS progress and witness how the DSS will incorporate user requirements. The proposed method of user involvement at SBHACH, which is a combination of the iterative and adaptive design methodologies, will be discussed in Chapter III in more detail.

D. ARCHITECTURE OF A DSS

So far in this chapter, less tangible DSS concepts have been presented, such as how DSS will aid decision makers, how decision makers should be involved in the DSS development process, and the structure of management problem areas best addressed by a DSS. It is now important to describe the more tangible components comprising a DSS and how these components interact. Figure 2-7 presents the three components of a DSS [Sprague 82].

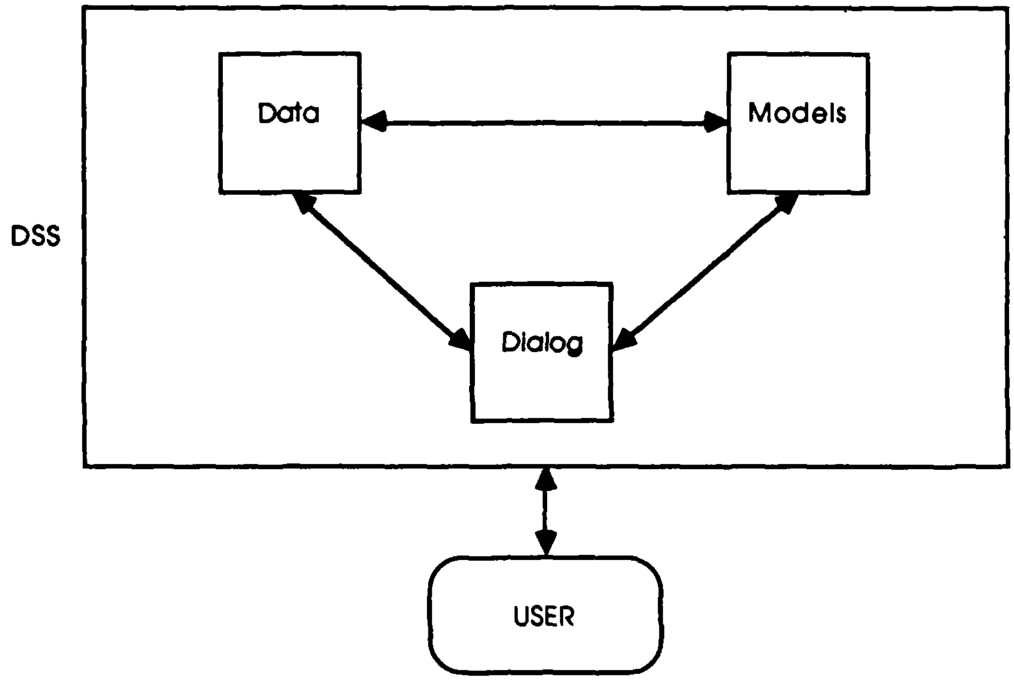


Figure 2-7. **DSS Sub-Components**

As shown in Figure 2-7, the user accesses the DSS through a dialog interface which drives the system by chauffeuring the decision maker through data extraction from databases, data manipulation by models, and presentation of results for decision making [Sprague 87]. By breaking a DSS down into the database, modeling, and dialog components, a builder can identify the requirements each component must possess to construct a DSS.

1. Database Component

The evolution of database technology in the past decade has made the addition of this component possible for use in a DSS integrated with the other components. The growth has moved from performing transaction processing and file management to adopting a database management approach with query languages to provide ad hoc reporting [Sprague 87].

a. Description

Decision makers often rely not only on internal data but on external data as well. The database component must extract and manage data from both sources as necessary to support user information requirements.

The database component must provide memory storage for extracted data prior to use, and data generated as output from modeling components. These storage and retrieval functions should be fast and transparent to the user [Sprague 82]. Another important characteristic the database component should possess is the ability to act as an intermediary between different models. The output from one model may be stored and used alone or combined with other model outputs as inputs to a second model and so on.

The data extraction system shown in Figure 2-8 [Sprague 82] functions as a data reduction tool to screen out superfluous data. It also serves to simplify the design of the DSS as well as collect and maintain data for use by the DSS. The separation of operational and DSS databases allows faster incorporation of added user requirements and responses to unanticipated requests [Sprague 87]. Chapter IV describes the databases that will need to be created making up the database component of the DSS for SBHACH.

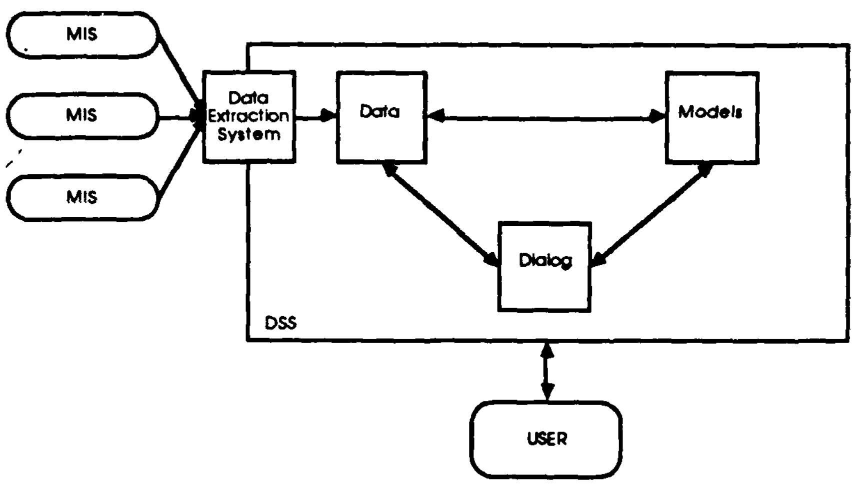


Figure 2-8. DSS Sub-Components With Data Extraction System

2. Modeling Component

The power of a DSS relies upon its ability to integrate data with models to manipulate information into a form useable by decision makers. The modeling component is discussed to introduce the concept of modeling and the way modeling plays an important role in decision support.

a. Description

As described earlier, the database component provides access to the large amount of raw data necessary for decision making. However, it is the modeling component that gives decision makers the ability to analyze this raw data [Sprague 82]. The modeling component acts as a tool to manipulate data into a meaningful form for decision makers. Sprague and Carlson suggest the modeling component

> provide a set of mechanisms for the use of decision/analysis models which draw on the data base and are closely related to it. It must also provide the dialog mechanisms for the decision maker to interact with the data and models in a convenient, supportive manner. [Sprague 82]

Use of model output as other model input was mentioned earlier. Each model usually requires data in its own format and supports only one distinct phase of decision making. It is important that the model component maintain a model base that contains a library of models. Models that are generic can be used repeatedly by the DSS and other DSS [Gorry 71]. Users find generic models easier to use due to the familiarity that comes with frequent use. A decision maker should be able to combine different models in a manner to manipulate data in support of a variety of decision problems.

Barbosa and Hirko present four characteristics that modeling components should possess [Barbosa 80]. To provide an enriched tool to the DSS, modeling should possess the following:

- System interfacing;
- User control;

- Flexibility;
- Feedback.

Interfacing allows the user to move in the DSS problem-solving environment without the needless interruption of interactively supplying too many parameters and variables to different models. The control the user should possess is found in manual versus automatic modes of operation. The user can manually select the algorithmic operation necessary to perform desired functions and operate in the modeling system as slowly as necessary to learn operating skills. By combining manual with automatic user operation, the modeling component will possess the flexibility necessary to flow outputs of one model as inputs to another in order to achieve desired results. Finally, feedback to the user is necessary to maintain control over the modeling process. The feedback should inform the user what state the solution generation is in at all times [Barbosa 80].

Brennan and Elam noted that modeling for DSS use has progressed at a modest rate and the emphasis must be put into "smart" modeling [Brennan 85]. The DSS must have a user interface when viewing the results of the model in an environment or framework that makes sense to the user. The interface must not only provide the results from model manipulations but also answer the question "Does the model produce sensible results?" in order to gain the trust of DSS users. Sprague and Carlson echo this finding by describing the lack of trust DSS users experience with large complex models.

> Decision makers do not put a great deal of faith in the results of complex models they do not understand the workings of, and major decisions may not be entrusted to modeling components if this trend prevails. [Sprague 82]

Although modeling is a vitally important function in manipulating large amounts of data, it is virtually transparent to the user. The dialog component, although just as important as modeling, is not transparent and is always in plain view of the DSS user.

3. Dialog Component

The last component of the DSS, the dialog component, is vitally important in that the user sees this feature of the DSS most often and forms opinions of like or dislike of the system as a whole based on this interaction. This component provides the DSS user interface. According to Keen, "from a user's perspective, the quality of the DSS largely depends on the quality of the dialog." [Keen 80] To foster flexibility of DSS use, the dialog component should cater to both novice and experienced users [Sprague 80]. This flexibility is important due to the turnover rates and shuffling of personnel common in military units. The DSS should provide the capability of guiding the novice user through the system when the user is changed to a new job using a DSS or temporarily filling a position for a short time.

a. Description

The dialog component can be broken down into three elements that collectively make up the system interface of the DSS. As shown in Figure 2-9 [Sprague 80], the dialog component is made up of the action language, the presentation language, and the user knowledge base [Bennet 77].

The action language is the hardware and software capabilities the system incorporates for the user to communicate to the DSS. It may consist of a keyboard, mouse, light pen, voice command, or other means necessary for the DSS to be used. The development of the action language should be dependent on user input skills with various hardware methods. The existing hardware and software within the organization must also be taken into account if the DSS is to be developed to run on those components.

The presentation language is the means by which the output is displayed to the user of the DSS. It is the method by which the output is written or graphically displayed on the computer screen. The presentation language is an important aspect of the

system because users have different cognitive styles. The importance of realizing this style difference and not attempting to incorporate user cognitive style in a DSS is discussed later in this chapter.

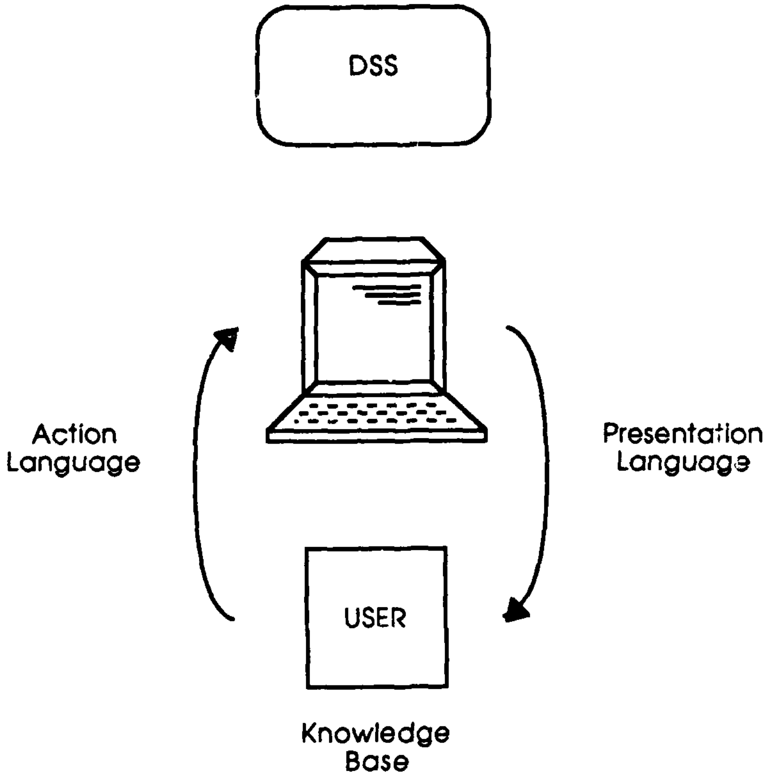


Figure 2-9. **The User System Interface**

The knowledge base is what the user must know to operate the system. This knowledge base may be inherent to the user or in a user manual, help keys, or note cards. The success of a DSS is often evaluated by whether it is used. Developing a dialog component that is easily understood and useable by novice and experienced users alike will produce a product that will be used by decision makers.

b. Constructing the Dialog Component

When developing a DSS for an organization, it is important to factor in the three elements of the dialog component for analysis. This is done by a skilled analyst through interviews and studies of existing databases and hardware components. After analysis is complete, the DSS builder should have an idea of the skill level DSS users possess and what hardware will be available to run the implemented DSS.

At the completion of interviews, the DSS builder will have a framework from which to develop the action and presentation languages. The action language can be determined early in the development process by studying decision makers at work with existing computer resources and taking informal surveys of skill levels. The hardware on which the DSS will operate often dictates the extent of the action language to be used. Determining the actual information to be presented to the decision maker determines the mode in which the information will be presented. If DSS users require a variety of information for forecasting and comparing trends within sub-units of the organization, then graphic capabilities will be required. Presentation requirements are addressed later in this chapter. Interviews are a good source for identifying how much the knowledge base should rely on the user and how much should be incorporated internal to the DSS and documentation.

Using an iterative approach by developing a small sub-problem of the DSS and submitting it to the user for his critique will have a positive effect on the development of the DSS. Primarily, it will provide a walk-through using sample input and output so the user becomes familiar with what the DSS will be like. The second effect is testing the user under field conditions. The builder can actually observe the user and find out where problem areas exist (e.g., data entry error rates) and make adjustments to the dialog component accordingly [Sprague 82].

Sprague and Carlson list several examples of dialog styles that could be employed by a DSS [Sprague 82]. These examples range from the basic one-line-at-a-time question-answer dialogs (Q/A), to progressive menu selection dialogs, to more complex command language dialogs. The development of the dialog component should thoroughly investigate which dialog style will best suit the DSS.

Q/A dialogs lead users through the system by presenting a series of questions that narrow down the scope until the desired information view is found. Menu-driven dialogs lead the user through different possible options available until the desired information view is obtained. Figure 2-10 provides an example of the menu dialog. In this figure, the user is offered one of four options. A selection of menu options one, two, or three will present the user with another menu option screen. This method guides the user through the different menu choices until the desired view of the data is found. Command language dialogs involve memorizing a series of verb-noun pairs (a command) which is typed into the computer to invoke a DSS function. For example, CALC MCCU will calculate the Medical Care Composite Units (MCCUs) over a given period of time.

PLEASE CHOOSE THE NUMERIC OPTION CORRESPONDING TO YOUR DESIRED MENU SELECTION.

1. Calculate Medical Care Composite Units (MCCUs).
2. Graph historic Medical Care Composite Units (MCCUs).
3. Perform Medical Care Composite Unit (MCCU) sensitivity analysis.
4. Exit the DSS.

PLEASE CHOOSE A NUMERIC OPTION 1 TO 4 ... ___

Figure 2-10. **Sample Menu Option Display**

In determining the appropriate dialog level, one factor considered often is frequency of use. The frequent user will eventually find the Q/A dialog style tedious and prefer the command dialog. Conversely, the infrequent user will see the Q/A dialog more accommodating since the command language dialog involves constant relearning of commands. Given the current problem environment, both user types could be expected to use the DSS. The menu-driven method should combine the respective advantages from the Q/A and command dialog styles that would benefit users. A number of alternatives are presented to the user on screen. Selection is made from these on-screen choices, thereby eliminating the need to memorize commands and the line-by-line process. A hierarchy of menus could be devised to provide a wide range of alternative displays.

The analysis of an organization to determine the content of the DSS architecture requires a substantial allotment of time and other resources. Managers need some type of tool to determine whether construction of a DSS be undertaken. The next section addresses the method to be used in justifying this construction.

E. JUSTIFYING A DSS

Although costs for computer hardware have been decreasing in recent years, allocation of funds for capital ventures such as computer systems still require a significant outlay of resources for most organizations. For a computer system to be designed, built, and maintained, some method of quantifiable payback is required. Historically, cost-benefit analysis is a tool used to choose between competing capital decisions by eliminating undesirable projects and highlighting projects that can be successfully undertaken.

1. Cost-Benefit Method

The cost-benefit method, although relevant for most system projects, is not well suited for DSS [Keen 81]. For this reason, the value analysis method is presented as an alternative to the cost-benefit method. As Keen points out, DSS provide benefits that are

qualitative and not quantitative. The key failure of using the cost-benefit method to evaluate a DSS is the inability to match associated costs and benefits to the proposed DSS.

The cost portion of a DSS is difficult to accurately pin down. How does one separate the different costs associated with a manager's time? The question asks "How much should be charged to building the DSS with regard to the cost of a manager's time used while conducting interviews and iterative reviews of the DSS?" Also involved are costs associated with sharing existing computer hardware and databases the DSS will require. What is a "fair share" of how much of the existing hardware the DSS will use on a daily basis? This percentage is difficult to predict prior to building a DSS.

Hogue and Watson point out that "many DSS are never finished but, continuously evolve [Hogue 84]." This brings out the question of what the costs will be with additions to the DSS and how these costs will be factored into the analysis.

Benefits also present a problem to managers. The benefits a standard computer system gives to an organization are quantifiable, while the benefits a DSS provides are mostly qualitative in nature. Keen presented examples such as viewing more alternatives prior to decision making, generating new ideas, and increasing communication of analysis. Managers examining potential benefits of a DSS cannot easily quantify these features for comparison against competing capital decisions. Another approach for analyzing the value of a DSS is required. This approach is the value analysis method.

2. Value Analysis

Keen states that value analysis proposes a systematic means of determining if a cost is justified on a product by concentrating on the following:

- Value first then cost;
- Simplicity and robustness;

- Reduction of uncertainty;
- Innovation.

This method allows projects to be analyzed that would otherwise be eliminated—it focuses on the estimates decision makers will have to provide to the DSS and how well it reduces the risk of the situation and adds innovation rather than imposing structure [Keen 81].

An approach focusing on the four elements presented above is used to develop the DSS. Developing a workin~ subset of the DSS by incorporating a few of the user requirements shows the user what benefits he will gain from the system and relates these benefits to a dollar amount spent. Decision makers can roughly interpolate the cost of the entire system, compare this cost with the benefits, and determine whether the development effort should proceed. This methodology is easily incorporated with the iterative and adaptive DSS building techniques and promises to deliver a product for an acceptable cost.

F. COGNITIVE STYLES OF DSS USERS

As alluded to in DSS architecture, the presentation language the DSS uses may influence the user's decision-making process. This section of the chapter will present two important points for discussion that should be considered when designing a DSS. The two points are (1) inconsistency of cognitive styles between individuals, and (2) the effects of presenting statistics and facts to users in relation to decision making.

Designing a DSS to incorporate a user's cognitive style, as attractive as this may seem, is not recommended by researchers [Huber 83 and Mann 86]. There are a number of reasons for not tailoring a DSS to fit the cognitive style of the user, primarily the erratic cognitive styles between individuals.

1. Inconsistency of Cognitive Styles

Miller points out that individuals, when presented with problems and alternatives, tend to recode or restate the presented information into a form that makes sense to the individual [Miller 56]. This reverbalization tends to draw upon the individual's own personal history and past experiences, thereby influencing what he perceives the problem to be. It is possible then that two different individuals observing the same information can draw very different conclusions. This inconsistency between individuals does not lend very well to testing an individual's cognitive style and incorporating it into a DSS.

Not only do inconsistencies exist between individuals, but inconsistencies within the same individual are evident when faced with different types of decision problems [Dickson 77 and Huber 83]. Their research indicated that the same individual has a different cognitive style when faced with a different type of decision. This implies that to incorporate a decision maker's cognitive style would require an analysis of his cognitive styles across different decision problems.

Although it is unwise to incorporate cognitive styles into a DSS, other options are available from hardware and software components that improve the overall decision-making quality. Using different dialog methods—user-guided or system-guided methods—can support novice users and experienced users. A series of experiments studying the impact of user-guided or system-guided dialogs on novice and experienced computer users supported this point [Benbasat 81]. Novice users had problems with the user-guided dialog and felt a need to be chauffeured by the system-guided dialog. This indicates a need for both system-guided and user-guided techniques within the dialog component of DSS.

The ability of DSS to provide different types of graphics to users is important. Benbasat's study also showed that although graphical reports decreased the accuracy of reported data, subjects tended to request these reports prior to decision making. Results

showed that, regardless of cognitive style of the subjects, data in graphical form will be widely requested from a DSS. It may therefore be important to design a DSS to show the same data in different graphical forms to better enhance user understanding and decrease possible misperception of data presentation across a variety of users.

2. Statistic Presentation Effects

A study by Tversky and Kahneman demonstrated the effect framing decision problems in different manners had on the selection of alternatives. They showed that the relative attractiveness of options varied when decision problems were framed in different manners [Tversky 81]. By framing options in a confusing manner, it is possible that decision makers may select an option they would normally not select. One of their studies dealt with allowing subjects a chance to choose between options that had probabilities of making a profit. By wording the options in a confusing manner, subjects were selecting options they would not normally choose. It is important when developing a DSS that alternatives are framed in an intuitive manner, in terms decision makers are familiar with.

The limited ability of humans to process information is important to consider when designing the presentation language of a DSS. Miller uses the "magical number seven plus or minus two" as a general rule [Miller 56]. He points out in his article that the human is capable of processing a limited amount of information at one time. In presenting menu options to users, a point of diminishing memory capacity is reached. Miller suggests that option presentation be kept near the number seven.

Another related experiment conducted by Benbasat dealt with the length of command words to use in an interactive dialog. The study was done to determine the effect different lengths of command words would have on two groups of subjects. One group used command words that were lengthy but was allowed to abbreviate them whenever

possible. The second group used abbreviated command words and was encouraged to type out the full word when group members were unfamiliar with the abbreviation.

The experiment yielded two results. The group using the longer command words had a tendency to abbreviate the commands as group members became familiar with the computer dialog. The second group (using abbreviated commands) preferred to type the command word in its entirety when group members were unfamiliar with the computer dialog [Benbasat 81]. If lengthy command words are incorporated in the user dialog, abbreviation should be allowed to cater to users familiar with the system. If abbreviated command words are used, they should be long enough for novice users to easily understand their meaning.

G. SUMMARY

In this chapter, a framework was established to aid the reader in developing an understanding about decision support and DSS. Concepts vitally important to the research were presented to provide a clear understanding of the characteristics and purposes of a DSS, and how to analyze, design, and build a functioning DSS.

Characteristics and definitions of a DSS were cited from several prominent researchers. The overall consensus was that DSS aid decision makers in confronting ill-structured problems using models and data analysis. The aid DSS users received was the enhancements of computer technology and, more importantly, the greater understanding of the decision problem.

Two methods of planning and building a DSS were presented as an alternative to the systems development life cycle method. The iterative and adaptive methods, although focusing on different aspects of the decision-making environment, had very similar methods for developing a DSS. These similarities particularly concentrated on constant

involvement of the DSS user. Sub-problems of the DSS were developed and presented to the user for review. This feedback method was repeated until a working DSS was refined.

This chapter most importantly presented the three components of the architecture of DSS. The data, dialog, and modeling components are described in Figure 2-11, which will be used in Chapter IV to develop the DSS components. These components provide a concise schematic of the DSS structure for the author to systematically begin analysis and design. Chapter II provided the necessary guidance to analyze, design, and build a DSS. Chapter III will discuss the analysis phase of the SBHACH DSS.

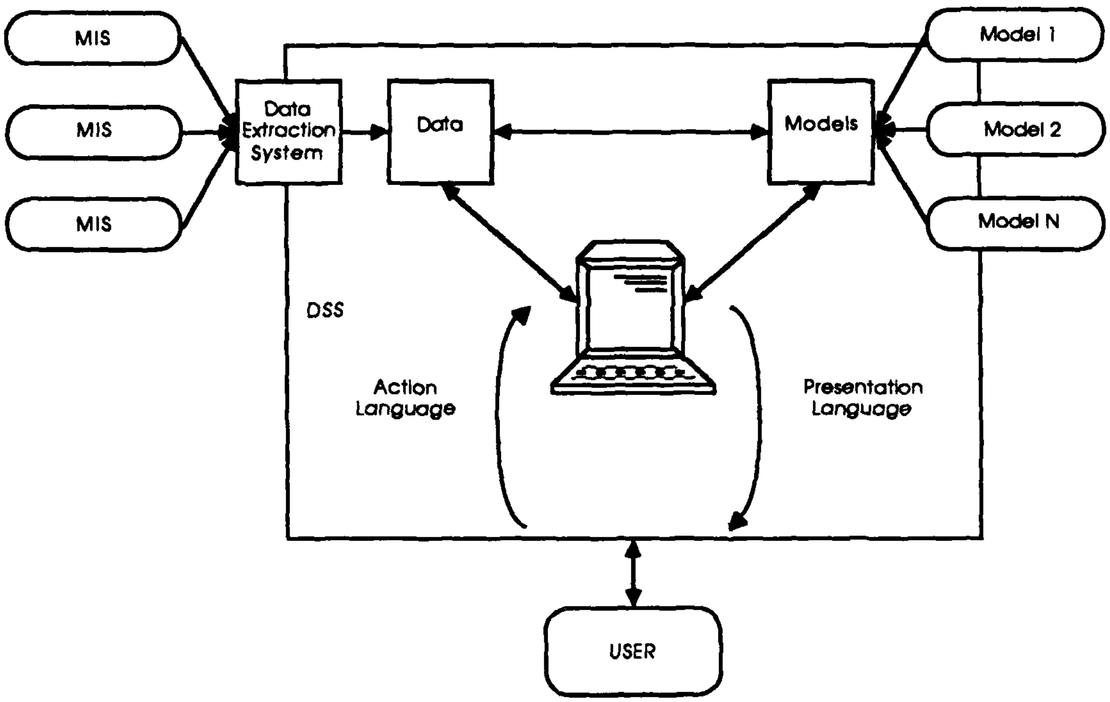


Figure 2-11. **DSS Component Diagram Expanded**

III. DERIVATION OF CRITICAL SUCCESS FACTORS

A framework for analyzing and designing a Decision Support System (DSS) was developed in Chapter II. The purpose of this chapter is to present the derivation of Critical Success Factors (CSFs) for Silas B. Hays Army Community Hospital (SBHACH). The organizational setting of SBHACH is presented with emphasis on how the proposed DSS will support hospital managers. The methodology used to collect CSF data from hospital managers is described and the derivation of organizational CSFs from collected data is discussed. Finally, the findings of the CSF methodology are presented, consisting of a discussion of each hospital CSF and proposed measures for satisfying the CSF.

A. SETTING

In order to gain an appreciation for the breadth and complexity of the management task facing the Hospital Commander and his staff, it is necessary to understand the organizational structure of SBHACH. This section describes the mission of SBHACH, discusses the chain of command, and discusses the current methods administrators use to manage hospital resources, including a description of existing Management Information Systems (MIS). As presented in Chapter II, DSS are best justified and tailored to support upper-level managers. This section also identifies the specific upper-level management positions in the hospital chain of command that will be supported by the proposed DSS (Resource Management DSS).

1. Mission of SBHACH

The mission of SBHACH is to provide quality health-care services to authorized personnel within the Fort Ord Health Services Area. This includes inpatient and outpatient medical treatment to active duty and retired personnel, their dependents, and other

personnel as authorized by the Department of the Army [Army Reg 40-3 85]. This broad mission statement neatly summarizes the purpose of SBHACH, but accomplishing this task requires the combined efforts of many skilled health-care providers and resource managers.

2. Chain of Command

Figure 3-1 [Army Reg. 40-3 85] depicts the organizational structure of the major internal departments of SBHACH. The operational clinics and wards, consisting of the departments of medicine, surgery, psychiatry, etc., are consolidated under the Deputy Commander for Clinical Services, who reports directly to the Hospital Commander. Each operational department is responsible for providing diagnosis, care, and treatment in its respective field of medicine. The Clinical Support Division aids the Deputy Commander for Clinical Services by providing budget planning, coordination, preparation, and supervision [Army Reg 40-3 85].

The Deputy Commander for Administration also reports directly to the Hospital Commander and is the principal staff advisor to the commander on management and administrative matters. Reporting to the Deputy Commander for Administration are several miscellaneous divisions providing administrative record keeping, information reporting, and data processing support, including the Resource Management Division. The Resource Management Division is a primary source of information the Deputy Commander for Administration uses to administratively monitor key areas within the hospital.

3. Current Resource Management Methods

SBHACH has several existing MIS in place that contain data essential to providing resource managers with needed decision-making information. This data and data from prepared reports are not readily useable; they require processing prior to presentation to decision makers. The current method of obtaining needed data from the various

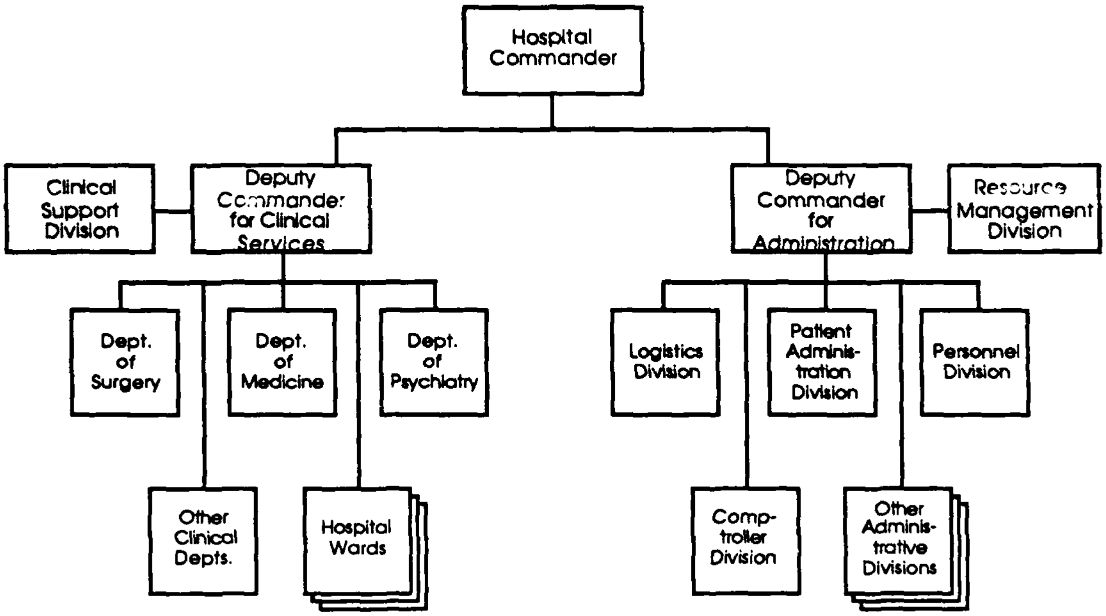


Figure 3-1. **Silas B. Hays Army Community Hospital Chain of Command**

functional areas of the hospital is to extract data available from the different MIS and prepared reports, manipulate the data into a useable form, and present the data to decision makers for analysis. When faced with decision problems, resource managers analyze these reports and MIS output for needed information. This section provides a description of the different MIS at SBHACH which currently provide data to decision makers.

a. Automated Quality of Care Evaluation Support System (AQCESS) Management Information System

The AQCESS MIS is a relatively recent addition to the hospital, having just been implemented at the first of the year (1988). "Bugs" are still being worked out, but it is still useful. The AQCESS system runs on a DEC 1184 computer and provides information to all clinics about patients and health-care providers. Each clinic is provided with a separate terminal accessing the DEC 1184 mainframe. The system provides quantitative information about the health-care services provided by health-care providers and the inpatients receiving these services at SBHACH.

The AQCESS system has three modules: *appointment scheduling, quality assurance,* and *patient data*. The appointment scheduling module is a decentralized appointment scheduling system that is slowly replacing the existing centralized appointment scheduling system in the hospital. The appointment scheduling module allows the clinics to schedule their own appointments, schedule appointment referrals to other clinics, record appointments kept, record walk-ins, and provide printouts to clinics on future and past schedules. This module offers a number of views of data and may be broken down by patient, clinic, or health-care provider over varied time periods. Statistical information is provided by this module which is helpful in determining clinic and health-care provider workload levels.

The quality assurance module is used to provide profile, monitoring, and general quality assurance reports. The profile reports give specific information on health-care providers. The information provided includes education history, personal and professional credentials, and credential renewal lists. Also provided are historical listings of specific patients and medical cases the health-care provider has treated.

Monitoring reports are provided on both clinic and health-care providers. A general list of the types of health care provided, such as surgery, physical therapy, etc., is provided by clinic and identifies patients treated. Another important monitoring tool identifies by patient name if a specific health-care provider is delinquent in updating medical records. The last reports provided by the quality assurance module are general quality assurance reports. These reports summarize important data such as blood use, patient deaths, and readmission of patients.

The third AQCESS module is the patient data module. This module provides a comprehensive record of inpatient data throughout the hospital wards. The data is a

conglomeration of necessary information about inpatients and is used by the Patient Administration Division.

The AQCESS system provides both routine and ad hoc reports. Some reports are provided every 24-hour period; specifically, the clinic schedules for the next day are routinely routed to all clinics. A smaller number of reports are requested on an ad hoc basis whenever specific information is required by resource managers [Appendix D].

b. Uniform Chart of Accounts Performance Expense Reports System (UCAPERS) Management Information System

The purpose of the UCAPERS system is to collect and report on two Uniform Chart of Accounts data elements. The Uniform Chart of Accounts is a uniform accounting procedure established in 1979. This procedure makes all military hospital commands report on three types of accounting data in a consistent and uniform manner. The three types of data reported quarterly to higher commands are expenses, personnel usage, and workload statistics. The UCAPERS system reports personnel expense and usage data.

The system records work performed by civilian and military health-care providers, stores this data, and submits it to Health Services Command (HSC) in a form so HSC can provide reimbursement of funds to SBHACH for health-care services provided.

The system runs on Datapoint hardware connected on an Attached Resource Computer (ARC) network of microcomputers throughout the hospital. The importance of this MIS is that it is the basis for which output in the form of health-care services provided is related to input in the form of budgetary allocation [Appendix D].

c. Standard Installation Divisional Personnel System (SIDPERS) Management Information System

The SIDPERS MIS is a personnel information system keeping records on all assigned military personnel at the hospital. It is a personal computer system made by Burroughs Corporation that is deployable to remote sites.

SIDPERS maintains records of military personnel assigned to SBHACH on a hard disk internal to the computer. The data fields contain standard data on each soldier as well as detailed information on education, training, sex, religion, next of kin, etc., that is necessary to the smooth functioning of military organizations. As information on a soldier changes, or personnel are deleted or transferred, the database is updated to reflect the correct information.

Each working day, the changes occurring over the past day are copied onto a floppy disk and hand-carried to the SIDPERS on post at Fort Ord that maintains the database post-wide. SIDPERS software allows users to view the database in different ways. It possesses the capabilities of a relational database that is menu driven to provide quick access to data that satisfies some ad hoc queries. In addition to this function, SIDPERS also provides word-processing capabilities [Appendix D].

4. Application of Resource Management DSS

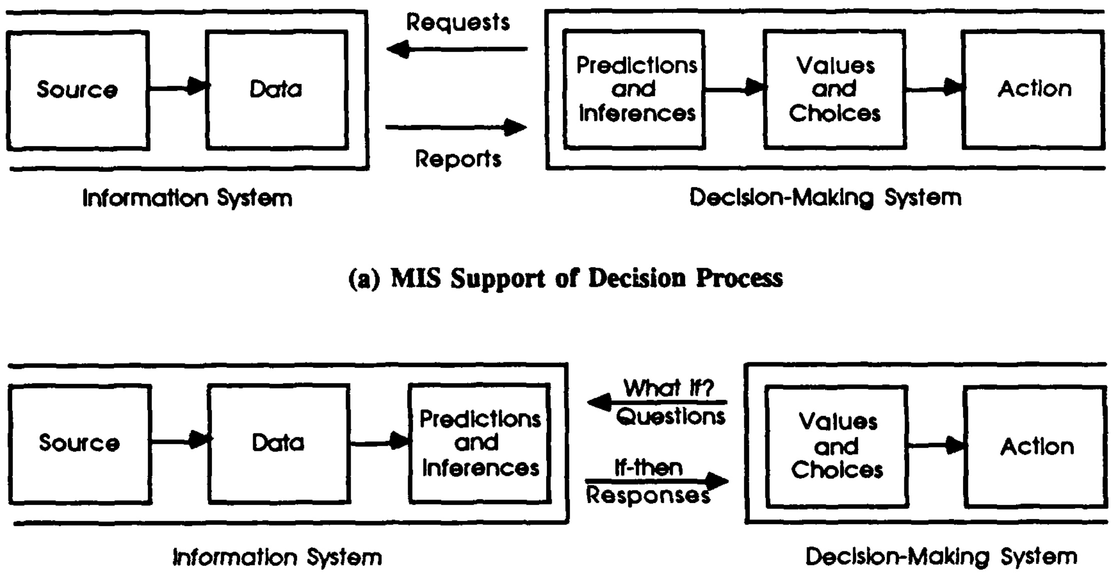
The Resource Management DSS will be used to help upper-level managers deal with ill-structured problems in a manner better than the present resource management method. The Resource Management DSS will go a step beyond the MIS level of decision support described in Chapter II and will support specific managers in the hospital chain of command. The use of the MIS to support the Resource Management DSS is discussed as well as managerial positions using the Resource Management DSS.

a. Use of MIS to Support Resource Management DSS

As described in Chapter II, there is a separation of information gathering and decision making that occurs with the use of MIS and DSS technologies. The information system is used to store and collect data. The decision-making system is the actual resource manager or managers tasked with analyzing the collected data, making predictions and drawing inferences from the data, assigning values from inferences drawn, and taking action [Mason 81].

MIS and DSS technologies separate the information-gathering and decision-making systems in different manners. Figure 3-2(a) [Mason 81] represents support an MIS lends to the decision process. The information system is tasked with storing, retrieving, and classifying potentially useful data for the decision-making system. The decision-making system then determines from which areas the data must be retrieved and makes these requests to the information system. Mason points out that it is not feasible for the information system to have the capability of retrieving all combinations and permutations of possible requests. Therefore, the decision system is tasked with generating these requests, drawing inferences and predictions from delivered reports, assigning values, and choosing a course of action. Resource managers at SBHACH request data from the different MIS within the hospital to address specific problems. Data is then analyzed and a course of action is chosen.

The Resource Management DSS for SBHACH will go a step beyond the MIS level and provide predictive information to decision makers. Figure 3-2(b) combines the ability to make predictions and draw inferences from the data. In this manner, the decision-making system (people) can ask "What if?" questions and get appropriate, timely responses from the information system. The people then assign values to possible choices



(a) MIS Support of Decision Process

(b) DSS Support of Decision Process

Figure 3-2. **MIS and DSS Support of Decision Process**

and take action. The Resource Management DSS is designed to allow resource managers to readily access databases created by the DSS consisting of extracted data from the AQCESS, UCAPERS, and SIDPERS MIS. Resource managers can ask "What if?" questions and project future trends based on historical data. From these responses to queries of the information system, the decision-making system can take action on values assigned to the different possible choices and choose a course of action.

Chapter II also presented a DSS acting as an intermediary between the user and MIS. Figure 3-3 [Sprague 82] shows the data-extraction system taking needed data from the UCAPERS, SIDPERS, and AQCESS MIS and creating databases for use by the DSS. Some of the databases created will be used for providing routine information, while other databases will be temporarily created and discarded after use. Chapter IV describes the databases to be created to support the the Resource Management DSS.

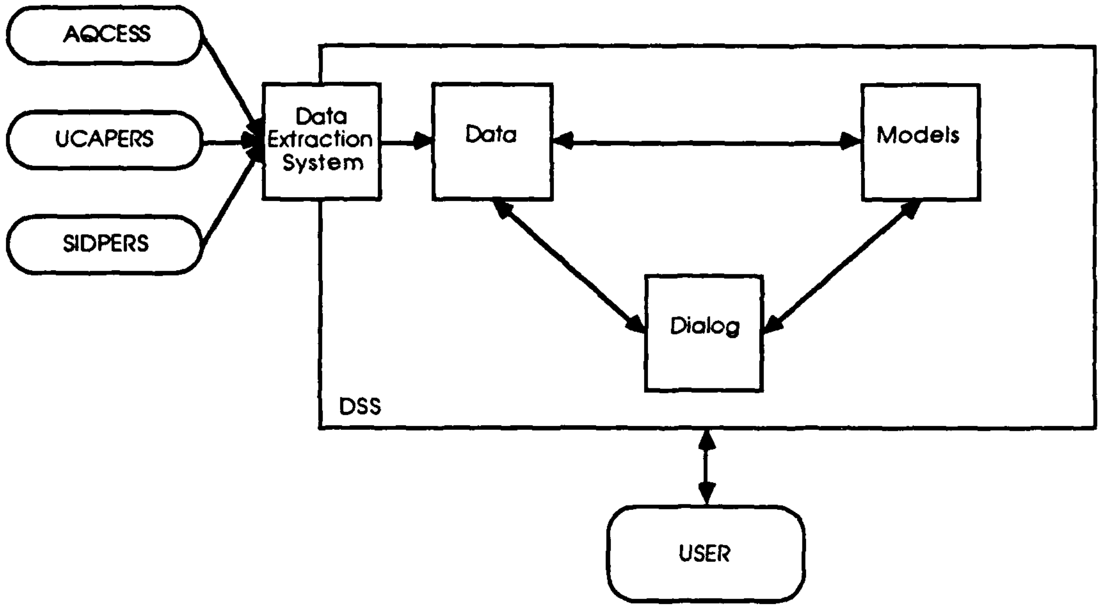


Figure 3-3. **DSS Sub-Components With Data Extraction System**

b. Managers Supported by Resource Management DSS

The Resource Management DSS will support primarily managers in the Resource Management Division and the Clinical Support Division. The Resource Management Division is responsible for providing a variety of services pertaining to the programming, budgeting, accounting, review, and analysis of overall resource usage. The Clinical Support Division is responsible for providing centralized administrative management support to all professional elements of the hospital [Army Reg 40-3 85].

The Clinical Support and Resource Management Divisions report directly to the Deputy Commander for Clinical Services and Deputy Commander for Administration, respectively (see Figure 3-4). The importance of emphasizing this relationship is clear. The two divisions using the DSS can act as facilitators to their respective deputy commanders, who in turn advise the Hospital Commander. Managers in these divisions can operate the Resource Management DSS and provide answers to ad hoc requests as well

as routine queries. Figure 3-4 also served as a starting point when initially identifying resource managers that would provide information from which CSFs could be determined.

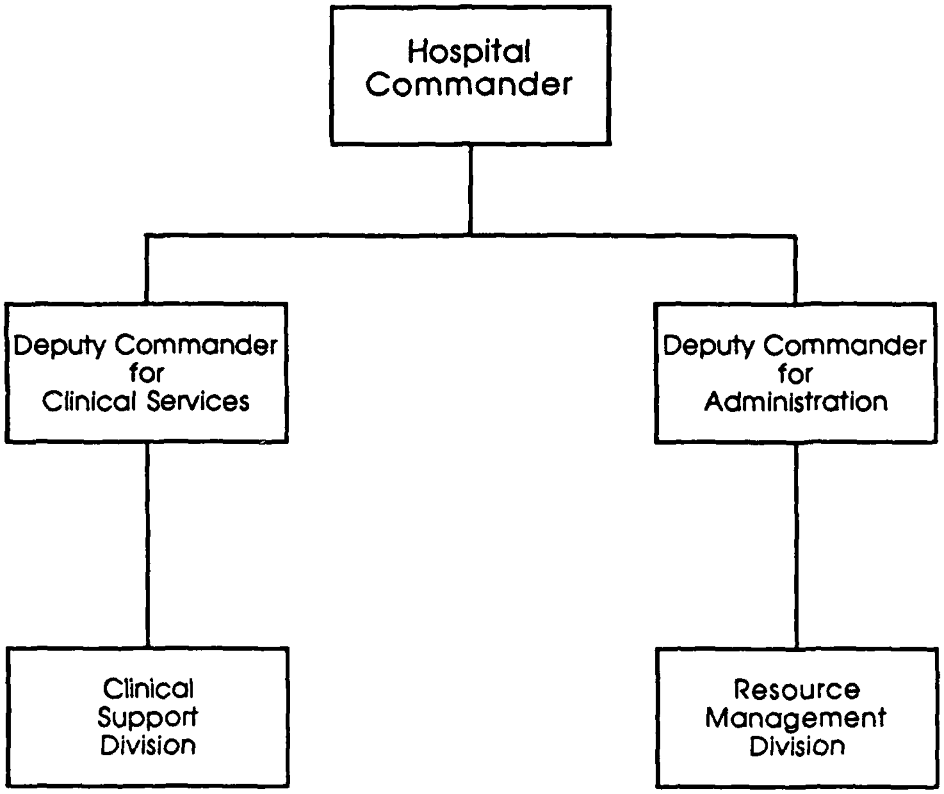


Figure 3-4. **Managers Supported by DSS**

B. METHODOLOGY OF CSF STUDY

Although CSFs were introduced in Chapter I, a more in-depth discussion of CSFs is needed. This section also discusses the methods used to collect data to determine hospital CSFs and the way CSFs are derived from collected data.

As a review, Bullen and Rockart describe CSFs as:

> the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department or organization. CSFs are those key areas where "things must go right" for the business to flourish and for the manager's goals to be attained. [Bullen 81]

The most difficult part of analyzing management information needs is eliciting what "key areas" of business activity are necessary to reach established goals [Rockart 82]. CSFs give insight into the organization and aid in planning and developing information systems to support data requirements needed to monitor organizational CSFs.

A review of the literature on CSFs identified seven primary sources of CSFs [Bullen 81]. Table 3-1 lists these seven CSF sources, describes each source, and provides an example relevant to the health-care industry. Bullen and Rockart stress that each source should be investigated thoroughly in order to elicit all CSFs pertaining to an organization.

1. Method of Data Collection

Bullen and Rockart describe the use of structured interviews to identify "key areas" that managers need to monitor in order to be successful [Bullen 81]. Structured interviews of key resource managers throughout the hospital chain of command were used. Interviews conducted identified key areas important to SBHACH managers and discovered the information needs currently used or desired by administrators in order to satisfy these needs. Interviews of personnel tasked with operating the various MIS were also conducted as well as data collection in the form of participant observation.

a. Upper Level Management Interviews

The author conducted a series of structured interviews with upper-level managers at the hospital. A preliminary interview and six CSF interviews were conducted to collect data on the information requirements necessary to properly manage hospital resources.

One hour-long interview was conducted in order to identify preliminary problem areas and determine whether a DSS could aid in solving these problem areas. The Chief of Resource Management Division and the Chief of Clinical Support Division were interviewed.

Six hour-long structured interviews were next conducted to identify specific CSFs. A structured interview questionnaire developed as part of the thesis (Appendix B) was used to elicit the different CSFs by focusing on CSF primary sources identified in Table 3-1. The following personnel were interviewed in the order listed:

- Nursing Methods Analyst
- Chief of Patient Administration Division
- Chief of Personnel Division
- Deputy Commander for Administration
- Deputy Commander for Clinical Services
- Commanding Officer, SBHACH

The top-down approach is a method described by Bullen and Rockart to move from an individual manager's focus on business objectives to an information systems focus. In the course of the interview, the manager is encouraged to discuss his business environment, consisting of his strategies, goals, and objectives [Bullen 81]. Figure 3-5 [Bullen 81] demonstrates that as the manager identifies the goals, strategies, and objectives that he holds within his sub-organizational element, he invariably identifies reports and sources of data that satisfy his information needs. From these reports and data sources, analysts are able to design databases and information systems that will provide managers with needed information to make decisions supporting his goals, strategies, and objectives.

Bullen and Rockart also suggest that structured interviews start at the lowest level possible in the organizational level and work upward [Bullen 81]. After the researcher became familiar with the organizational structure and current information management practices, structured interviews were conducted by starting at the lower levels and progressing upward. By starting at the lower levels, important knowledge was gained in

TABLE 2-1

PRIMARY SOURCES OF CRITICAL SUCCESS FACTORS

[based on Bullen 81]

Primary Source	Description	Example
1. Industry	Factors determined by the industry itself	Quality of health care to patients
2. Competitive Strategy and Industry Position	Industry position in which the organization finds itself	Surrounding communities' expectation of health-care services
3. Environmental	Areas over which the organization has very little or no control	Fluctuation of patient levels
4. Temporal	Areas that become temporarily important for a period of time	AIDS concern
5. Managerial Position	The different factors that are important to different managers with the organization	Accuracy and timeliness of lab results to the individual clinics
6. Internal and External	Factors that are inside an individual manager's sphere of influence or external to a manager's control	Clinic staffing levels *are not controllable* by individual clinic chiefs, but *are controllable* by the hospital commander
7. Monitoring and Building	A difference in classification of whether a manager is more concerned with tracking the organization's progress (monitoring) or planning the next move (building)	Monitoring—tracking seriously ill patients Building—analyzing plans to open a new inpatient ward

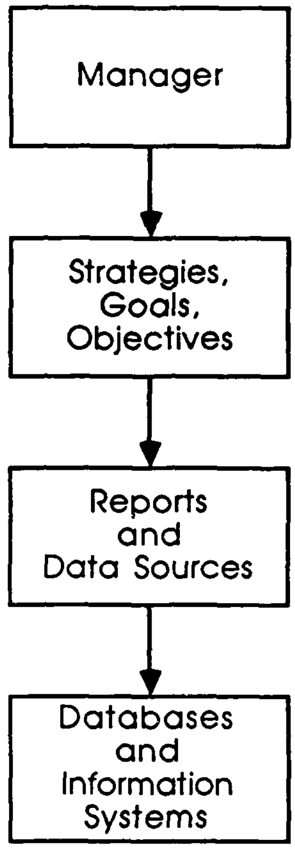


Figure 3-5. **Manager's Business Environment and Focus: Strategies to Information Systems**

order to become more comfortable in conducting interviews further up the hospital chain of command. Reports and databases were identified in the lower levels and the interviewer became more knowledgeable in the organizational workings and identified where data originates and how it is processed before finally getting to upper-level decision makers. As CSFs were discovered, it was found that the lower-level managers were an important source of identifying where data was extracted from and that higher-level managers were beneficial in prioritizing CSFs.

b. Information Management Personnel Interviews

Three hour-long interviews were conducted with information management personnel responsible for the maintenance and upkeep of the many MIS in operation at SBHACH. The purpose of these interviews was to provide a description of the different MIS that maintain relevant data used by resource managers.

c. Participant Observation

The final method of data collection was participant observation. This data-collection method consisted of observing several information management meetings conducted by managers and by analyzing reports and databases throughout the hospital. The information management meetings provided a focus from which trends and directions of the development of organizational information technology could be studied.

2. Derivation of CSFs

Bullen and Rockart provide a methodology for deriving an organization's CSFs from the data collected during structured interviews. The key to successfully determining organizational CSFs is in determining the individual manager's CSFs. Each manager is interviewed, concentrating on the seven primary source of CSFs listed in Table 3-1 [Bullen 81]. The emphasis is to ensure that all potential sources of CSFs are discussed to "leave no stone unturned." The manager's CSFs are then listed and prioritized.

The next step described by Bullen and Rockart is the aggregation of individual managers' CSFs. The researcher takes each manager's CSFs and combines all CSFs into an organizational view. This aggregation is conducted with the focus on extracting the organization's CSFs and prioritizing them [Bullen 81]. The next section will discuss the data collected and the organizational CSFs derived from the data.

C. CRITICAL SUCCESS FACTOR FINDINGS

The previous section discussed the methodology of the CSF research, describing how CSF data were elicited from upper-level managers and how an organization's CSFs are derived from individual manager CSFs. This section identifies the appendices summarizing the data discovered during structured interviews and presents the SBHACH CSFs.

1. CSF Data

The interviews conducted at SBHACH are summarized in Appendices A, C, and D. The positions of resource managers are identified, but the names of personnel interviewed were not included even though nothing inappropriate was discussed during interviews. These appendices served as documentation for the development of the SBHACH CSFs.

The structured interviews conducted with upper-level managers are presented in a partitioned format. The interviews are separated by each individual manager and presented in the order in which they occurred. Each interview is divided into the seven primary sources of CSFs, as shown in Table 3-1. Data discovered was placed into one of the primary CSF sources. Summaries of the six upper-level management interviews conducted at SBHACH are found in Appendix C.

The interviews conducted with management information personnel are summarized by the type of MIS that the particular individual was responsible for maintaining. All detailed information about existing MIS at SBHACH was discussed during these interviews, which are summarized in Appendix D.

2. Presentation of CSFs

An analysis of the data collected during CSF interviews indicated that SBHACH had four CSFs. These four organizational CSFs are the major concerns on which upper-level managers at SBHACH must focus their attention. The four CSFs are

presented in this section, along with proposed measures the Resource Management DSS should be able to provide in order to satisfy information needs. Also discussed are project requirements that are of an information systems focus which the Resource Management DSS should also provide.

a. *Critical Success Factor 1: Maintain Sufficient Fiscal Resources to Meet the Demands For Inpatient and Outpatient Health-Care Services*

Medical Treatment Facilities (MTFs) were established to provide medical care to authorized DOD personnel and their dependents. Although these MTFs are non-profit oriented, they still must somehow account for the large expenditures of funding provided by DOD. Health Services Command (HSC) must monitor these MTFs and provide funding in relation to some quantifiable measurement of services rendered by the individual hospitals.

The current trend is for MTFs to be reimbursed relative to the health-care services that they provide [Appendix A]. HSC closely monitors each hospital, measures their expenditures in health-care services rendered, and reimburses them in relation to this expenditure.

The current system of reporting to DOD the amount of health-care services provided by the MTF is based on a unit called a Medical Care Composite Unit (MCCU). When health-care providers (doctors, nurses, lab technicians,...) provide services to patients in the form of consults, surgery, pharmaceutical prescriptions, bed space, radiology, and other varied services, the MTF is credited with MCCUs depending on the type of service. For example, an outpatient visit is worth roughly 0.3 MCCUs, a live birth is valued at 10 MCCUs, and admission as an inpatient is worth 10 MCCUs the first day and 1 MCCU every day thereafter. All health-care services provided are input daily by data entry clerks and maintained on a MIS. The information is updated daily, and weekly a tape is

run summarizing all health-care services provided by the MTF for the past seven-day period. A copy of the tape is sent to a DOD-run facility where the data is calculated into MCCUs. These MCCUs are used by DOD quarterly to provide monetary funding to SBHACH in reimbursement for health-care services provided at the MTF. A hard-copy report is forwarded to the MTF one month after the quarter has expired summarizing the MCCUs earned for the previous quarter [Appendix C].

The proposed measures of the Resource Management DSS for satisfying this CSF should maintain a productivity database that accurately provides performance and productivity criteria to resource managers that will do the following:

- Compare current clinic work unit levels to historic values.
- Forecast future clinical productivity using historic data and user-projected values.
- Forecast future hospital productivity using historic data and user-projected values.
- Compare current MCCU data to historical data and projected goals.
- Project future MCCU values based on current trends of MCCU earnings and user-projected values.
- Calculate unused capacity in the form of bed space and potential discharge information.
- Calculate projected bed space required based on current trends.

The system should also provide functions that are of an information systems focus along with the DSS provided measures. The Resource Management DSS should also do the following:

- Calculate monthly work units accomplished by individual clinics.
- Calculate the number of MCCUs earned by the hospital to date.
- Graph and chart work units accomplished over time for presentation to decision makers.
- Calculate the entire hospital's earned MCCUs each day to an acceptable degree of accuracy, and compare the moving average to projected goals.

b. *Critical Success Factor 2: Maintain Sufficient Military and Civilian Personnel to Adequately Provide Health-Care Services to Fluctuating Inpatient and Outpatient Levels*

This CSF deals with properly staffing wards and clinics to meet the fluctuating demand of inpatients and outpatients. By providing an adequate number of health-care providers at varying levels of demand, the hospital will provide an acceptable level of medical care to all personnel authorized medical care at SBHACH. At present, civilian and military levels are tracked by the Personnel Division. When fluctuating patient levels and operational commitments overburden the staffing levels of wards and clinics, decisions must be made to reallocate health-care providers. Decisions must also be made when hiring civilians to replace vacant positions within the hospital [Appendix C].

The proposed measures for the Resource Management DSS satisfying this CSF are to maintain a manpower database to include all officer, enlisted, and civilian personnel assigned to the hospital that will do the following:

- Project gains/losses for six months in the future for military and civilian personnel.
- Forecast clinical staffing levels from historical data and user-projected input.
- Compare different clinical productivity levels at the same time.

The system should also provide functions that are of an information systems focus along with the DSS provided measures. The Resource Management DSS should also do the following:

- Compare onboard count to authorized billets hospital wide as well as at the clinic level.
- Maintain required qualification records on military health-care providers assigned to deployable forces.

c. ***Critical Success Factor 3: Monitor the Impact of the Primary Care to Uniformed Services (PRIMUS) Clinics and the Civilian Health And Medical Program of the Uniformed Services (CHAMPUS) Reform Initiative***

The two PRIMUS clinics being opened at The Presidio of Monterey and Salinas, California, are designed to provide health-care services to active duty, retired, and dependent personnel as an alternative to the medical treatment also provided at SBHACH. The medical care is provided mostly by civilian personnel under contract and covers small injuries, common illnesses, and general medical problems. Although the two PRIMUS clinics will duplicate a percentage of medical care that is already provided at SBHACH, there are certain medical services not rendered.

SBHACH will still offer all medical services, but the PRIMUS clinics will take some of the workload from the hospital and give additional medical care to the surrounding military community. The PRIMUS clinics can have three effects on the hospital: they may "steal patients away" from the hospital and cause the overall hospital productivity to drop; they may increase the amount of patients treated through patient referrals; or the patient levels will remain the same.

The CHAMPUS reform initiative is a program sponsored by HSC to retard the yearly costs of CHAMPUS, which currently are rising at a rate of 25 percent per year. In effect, the purpose of the CHAMPUS reform initiative is to identify a number of health-care providers outside the military hospital system who can provide medical care for the overflow of patients at SBHACH less expensively than their contemporaries. These health-care providers under contract will cost the government less in CHAMPUS costs then the current method of using more expensive outside medical practitioners [Appendix C].

The proposed measures for the Resource Management DSS satisfying this CSF are to maintain a database that contains the fluctuation of inpatient and outpatient

treatment during the opening of the PRIMUS clinics and the start-up of the CHAMPUS reform initiative that should do the following:

- Measure the daily fluctuation of clinic productivity in work units compared to historical values.
- Forecast the number of outpatients in the future based on historical referrals from the PRIMUS clinics.
- Measure the daily fluctuation of clinic MCCUs earned compared to historical values.
- Project trends of outpatient drops due to loss of outpatients to PRIMUS.

The system should also provide functions that are of an information systems focus along with the DSS-provided measures. The Resource Management DSS should also do the following:

- Monitor the number of patients treated due to referrals from the PRIMUS clinics.
- Calculate the daily loss of MCCUs due to drops in outpatient levels.

d. Critical Success Factor 4: Maintain a Sufficient Amount of Medical Equipment in Proper Working Order to Provide Necessary Health-Care Services to Inpatient and Outpatient Demands

SBHACH makes significant budget expenditures on capital equipment each fiscal year. There are varying life cycles of different types of equipment, and occasionally the equipment does not last the entire life cycle and must be budgeted for earlier than expected. An important information requirement is to accurately project future requirements of equipment which will have to be planned for in the yearly budget [Appendix C].

The proposed measures for the Resource Management DSS satisfying this CSF are to maintain a database that tracks major items and contains records on cost, serial numbers issued, acquisition date, expected life cycle, anticipated expiration date, and other pertinent information. The proposed measure should do the following:

- Forecast future monthly budget expenditures on capital equipment based on historical data.
- Forecast future monthly budget expenditures on capital equipment based on projected user input.

The system should also provide functions that are of an information systems focus along with the DSS-provided measures. The Resource Management DSS should also do the following:

- Calculate total cost of the yearly budget portion allocated for the purchase of capital equipment.
- Break down the equipment by functional wards and clinics and provide varied views of the database.
- Identify equipment approaching the end of its useful life cycle.

D. SUMMARY

This chapter discussed the derivation of SBHACH CSFs in preparation for the design phase of the Resource Management DSS presented in the next chapter. This chapter also discussed the organizational setting of SBHACH, the methodology of collecting data for analysis, and, most importantly, presented the four CSFs derived from collected data.

In discussing the organizational setting, the current method of resource management used by hospital administrators was presented. The three MIS used for data sources were presented in detail because these same MIS will be used by the Resource Management DSS to extract relevant data from. Finally, the actual managerial positions in the hospital chain of command which will use the Resource Management DSS were identified.

The next section of this chapter discussed the methodology used to collect data. The three methods of data collection—upper-level management interviews, information management personnel interviews, and participant observation—were presented. The personnel interviewed were identified by their position within the organization. The importance of

the interviews is stressed because the CSFs for SBHACH were derived from this collected data.

Finally, the organizational CSFs for SBHACH were presented in detail with the proposed measures which were developed to satisfy the information requirements of each CSF. Table 3-2 summarizes the four organizational CSFs derived from collected data. The next chapter will take a portion of these derived CSFs and design the first iteration of the Resource Management DSS.

TABLE 3-2

SBHACH PRIORITIZED CRITICAL SUCCESS FACTORS (CSFs)

Priority	Critical Success Factor
1st	Maintain sufficient fiscal resources to meet the demands for inpatient and outpatient health-care services.
2nd	Maintain sufficient military and civilian personnel to adequately provide health-care services to fluctuating inpatient and outpatient levels.
3rd	Monitor the impact of the Primary Care to Uniformed Services (PRIMUS) and the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) reform initiative.
4th	Maintain a sufficient amount of medical equipment in proper working order to provide necessary health-care services to inpatient and outpatient demands.

IV. DESIGN OF DECISION SUPPORT SYSTEM (DSS)

Chapter III discussed the analysis phase of the Resource Management Decision Support System (DSS) at Silas B. Hays Army Community Hospital (SBHACH) in order to identify critical information requirements needed by resource managers. Chapter IV takes information found during the analysis phase and, using structured design tools, provides necessary documentation from which the first iteration of the Resource Management DSS can be implemented.

As described in Chapter II, a small sub-problem of the DSS is agreed upon between user and builder. The builder designs a system and presents it to the user for feedback. The builder makes necessary corrections and repeats the process by building on the existing system [Sprague 86]. This first iteration of the Resource Management DSS will be presented to users for review and will serve as the system's cornerstone from which the full-scale Resource Management DSS can be constructed.

In order to design the first iteration, a partition of the DSS analysis is made and the design of a sub-problem is conducted. This chapter discusses a portion of the Critical Success Factor (CSF) that will be designed from this partition. A transformation from analysis to design using structured specification and module specification tools is described. In addition, this chapter also describes the Resource Management DSS construction using the data, dialog, and modeling components presented in previous chapters. The delivered product from this chapter will provide follow-on researchers with sufficient documentation to implement the first iteration of the SBHACH Resource Management DSS in a structured programming language such as PASCAL.

A. SIZE OF FIRST DSS ITERATION (VERSION 0)

Version 0 of the Resource Management DSS is limited to providing information and modeling capabilities to satisfy two of three proposed measures found in the first CSF. The first CSF is to provide information to decision makers in order to *maintain sufficient fiscal resources to meet the demands for inpatient and outpatient health-care services.*

The two areas from the first CSF to be satisfied are Medical Care Composite Unit (MCCU) earnings and productivity trends. A discussion of these two areas will provide the reader with an understanding of the type of information required to satisfy a portion of the first CSF.

1. Medical Care Composite Unit (MCCU)

The Resource Management DSS must provide decision makers with daily and monthly MCCU earnings. The most recent 30-day earning of MCCUs can be extracted and graphed to display MCCU earning trends. Resource managers can also monitor the number of MCCUs earned by the hospital to date for the current fiscal year.

A monthly database of the current and previous years' MCCU earnings will allow the comparison of recent data to the previous year's data. From this historical database, projections of the next six months' MCCU earnings can be made based on recent trends using a moving average calculation formula. Also, users can input predictions for future months and project up to six months of MCCU earnings in the future. Graphics in the form of a spreadsheet application will plot the MCCU earnings and save desired data to files for later use.

2. Productivity

Productivity databases will provide information about individual clinics as well as hospital-wide in the form of work units earned in comparison to health-care providers assigned. For both the hospital and individual clinics, the last six months of monthly

productivity earnings can be graphed on a spreadsheet application and saved for future use. In addition to historical trends, productivity projections can be made based on the last few months' earnings or based on the user's predictions of future months' productivity.

B. TRANSFORMATION OF ANALYSIS TO DESIGN

It is important to correctly transform the analysis into a system design. Page-Jones describes this procedure as taking the voluminous amount of information produced during the analysis phase and determining how to organize what it describes in a manner suitable for computer execution [Page-Jones 80].

The transformation of analysis to design is made in two steps. In the first step, the structured specification primarily uses three tools to logically describe the evolving system. The module specification is the second step and uses two tools to describe procedural detail. The by-products of these two design steps will provide sufficient documentation from which source code can be developed.

This section will describe the structured specification and the module specification design steps. The tools used to transform analysis to design will be discussed and specific examples presented from the Resource Management DSS. Finally, the appendices containing documentation from this design phase will be referenced.

1. Structured Specification

A structured specification is used to allow the system builder to clearly understand the workings of a system and create a design quickly and accurately showing what the system will do [Page-Jones 80]. Page-Jones describes a structured specification as having the following characteristics:

- Graphic and concise;
- Top-down partitioned;

- Non-redundant;
- Logical, not physical.

In other words, the structured specification contains pictures rather than text [Page-Jones 80]. Graphical representations of data, data flows, and processes are better understood than textual descriptions. The structured specification breaks the system down into smaller, independent pieces for easier understanding. It is also non-redundant in that the structured specification records a piece of information only once for consistency and accuracy. Finally, the structured specification focuses on what the system will accomplish for the user (the logical) rather than on how the system will be implemented by a particular machine [Page-Jones 80].

The structured specification primarily consists of the following three tools:

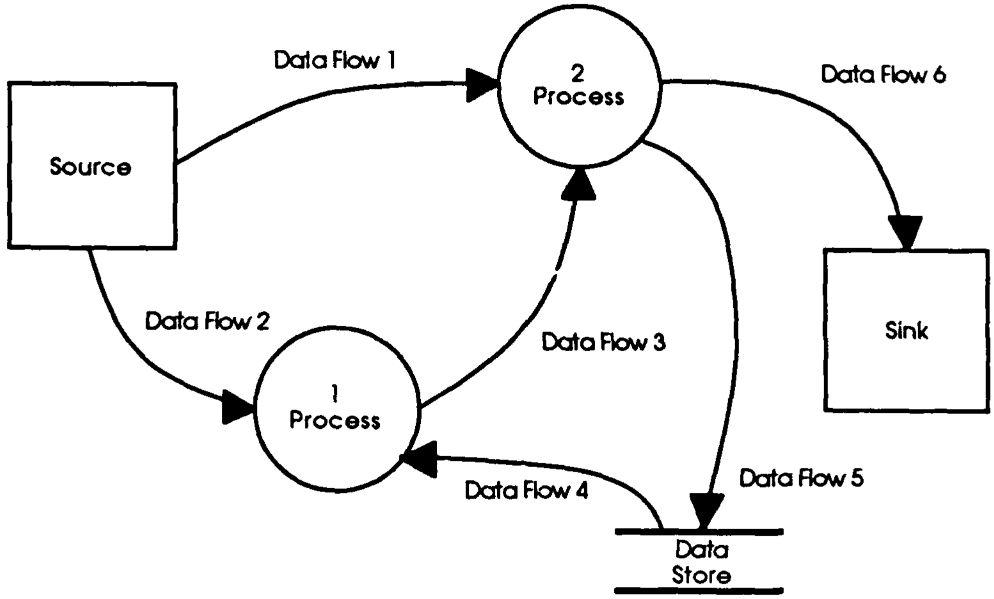
- Leveled Data Flow Diagrams (DFDs);
- Tools to describe policy;
- Data dictionary.

Using structured specification tools will enable designers to easily create a description of what the system is performing. The remainder of this section will describe these tools.

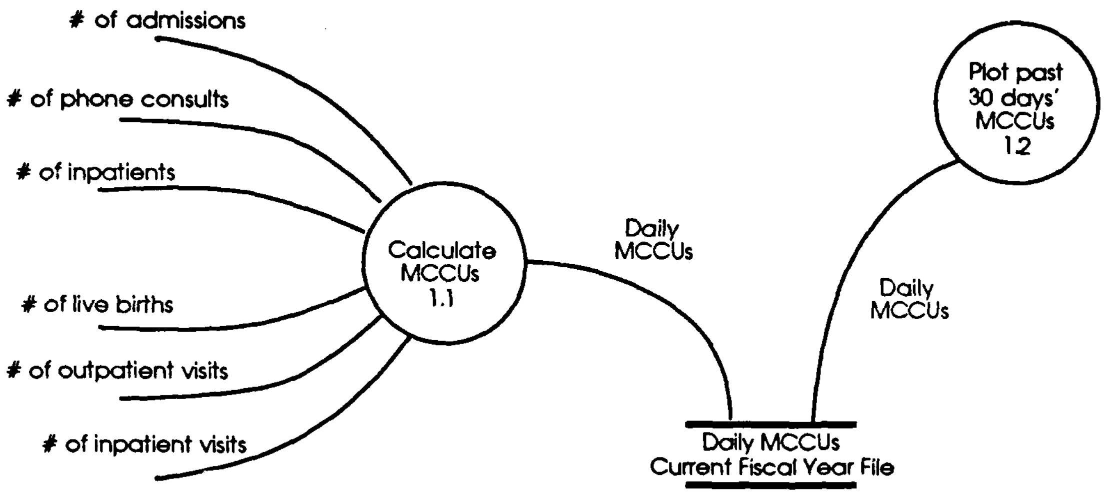
a. Leveled Data Flow Diagrams (DFDs)

The DFD is used to partition a system and is desirable because it is graphic, concise, and non-redundant [Page-Jones 80]. DFDs consist of four elements: data flows, processes, data stores, and sources/sinks. Figure 4 1(a) provides a sample DFD as it appears with all four elements. Figure 4-1(b) shows a portion of the DFD from the Resource Management DSS.

A data flow consists of data moving between processes, data stores, and sources/sinks. The name of the data flow is written beside the data flow and an arrow



(a) Data Flow Diagram Components



(b) Sample Resource Management DSS Data Flow Diagram

Figure 4-1. **Data Flow Diagrams**

indicates the direction in which the data are moving. According to Page-Jones, the data flow can be thought of as parts being delivered on a conveyer belt or a pipeline carrying pieces of data [Page-Jones 80].

A process is used to transform data in one of two ways. A process may transform the structure of data by reformatting it or may transform the information contained in the data [Page-Jones 80]. Note that in Figure 4-1(a), data flows going into a process do not have the same names as data flows leaving the process because the data was somehow changed. Figure 4-1(b) shows six different data flows coming into the process CALCULATE MCCUS and a single data flow leaving it. The six data flows coming in were used to generate a single data flow leaving the module.

A data store is a temporary storage area for data to be used by the system. In essence, data stores are the created databases used by the Resource Management DSS from which to extract data. The data store DAILY MCCUS CURRENT FISCAL YEAR allows the daily MCCUs calculated each 24-hour period to accumulate. On request from the PLOT PAST THIRTY-DAY MCCUS process, the last 30 days worth of MCCUs are taken from the data store and delivered to the process.

Finally, the last DFD sub-component is the source/sink. Sources and sinks are found on the edges of the DFD. They show where desired data originate and provide a final recipient of the finished product exiting the system [Page-Jones 80].

DFDs representing a system can be quite large and complicated, requiring a method of partitioning to separate the large DFD into understandable sub-components. The entire DFD is started by a context diagram indicated as level 0 and partitioned down through various layers until further partitioning is no longer practical. The lowest level processes are called functional primitives and are the building blocks of the context diagram [Page-Jones 80]. This top-down partitioning method will take a single process and will

show the details of that process in the form of a more detailed DFD. The small DFD portion found in Figure 4-1(b) describes a single process found at the next higher level of the DFD. The numbering system is used to denote hierarchy—sub-elements from process 1.0 are labelled 1.1, 1.2, 1.3, etc., clarifying details of larger processes. The input and output data flows from the superior process are the same for the subordinate sub-components. Appendix E contains the leveled DFD for the Resource Management DSS. The context diagram is presented first, and each process is leveled by describing it in terms of lower-level data flows, processes, and data stores. Appendix E presents a logical view of what the system is doing. The next section describes the method used to explain this graphical representation.

b. Tools to Describe Policy

Because the DFD shows partitioning of a system only, some method of describing each functional primitive must be used to specify the mechanics of the whole system. Mini-specifications, or simply, mini-specs, are used to describe each functional primitive. Only functional primitives are described because any other process is a conglomeration of functional primitives and violates the non-redundancy rule of structured specification. Page-Jones points out that the goals and objectives of the mini-specs tool are to ensure the following:

- There must be one mini-spec for each functional primitive in the DFD.
- The mini-spec must state the way in which the data flows entering the functional primitive are transformed into the data flows leaving it.
- The mini-spec should control redundancy by not restating something already stated in the DFD or data dictionary.
- The mini-spec should facilitate descriptions in a standard manner. [Page-Jones 80]

Mini-specs can be written in three ways: Structured English, the decision tree, or the decision table. Structured English is the method used to write the mini-specs for the Resource Management DSS and therefore is the only method described here.

Figure 4-2 is a sample mini-spec of the functional primitive CALCULATE MCCUS taken from Figure 4-1(b). The Structured English method describes what the functional primitive does to transform the data flows going into the process to the data flow leaving the process. Notice that the mini-spec uses verbs where possible and uses terms from the data dictionary which have a specific meaning [Page-Jones 80]. The mini-spec should be written to tell the programmer what is to be done rather than how to do it. Appendix F contains the collection of mini-specs explaining the functional primitives identified from the set of leveled DFDs.

1.1 CALCULATE MCCUS

For the past 24-hour period do the following:

1. Get number of admissions
2. Get number of phone consults
3. Get number of inpatients
4. Get number of live births
5. Get number of outpatient visits
6. Get number of inpatient visits
7. Calculate the number of MCCUs earned by:
    - 7.1 (Number of admissions) X ADMISSION_VAL plus
    - 7.2 (Number of phone consults) X PHONE_CONSULT_VAL plus
    - 7.3 (Number of inpatients - number of admissions) X CENSUS_VAL plus
    - 7.4 (Number of live births) X LIVE_BIRTH_VAL plus
    - 7.5 (Number of outpatient visits plus Number of inpatient visits) X CLINIC_VISIT_VAL

Figure 4-2. **Mini-Spec for Process CALCULATE MCCUS**

c. Data Dictionary

A data dictionary is the collection of all data elements that are found in the DFD, mini-specs, or even in the data dictionary itself. The data dictionary functions as a repository for the definition of all data elements. Data elements that are a combination of other data elements are further defined in the data dictionary until all data elements are described. The data dictionary is alphabetized to facilitate ease of use. Appendix G contains the data dictionary for the Resource Management DSS.

2. Module Specification

The second step used in designing the Resource Management DSS was the module specification. The module specification uses two tools—the structure chart and a written description of the function of each module. The goal of module specification is to take the DFD, which has very little procedural detail, and produce a structure chart which has a great deal of procedural detail. The structure chart, when accompanied by module specs, provides detail from which a programmer can develop source code [Page-Jones 80].

a. Structure Chart Transformed From DFD

By carefully studying the DFDs, a structure chart is drawn that depicts the entire system. The structure chart is drawn to partition the system into separate and relatively independent modules. Each individual module is responsible for a certain action within the system and represents a reasonable partition of source code that will be written by the programmer. The structure chart shows the hierarchy of the modules and a simple description of each module is provided through its name.

Figure 4-3 is a small subset of the Resource Management DSS taken from Appendix H. The module DO THIRTY-DAY TREND MENU CHOICE will contain the program source code that allows it to call on the subordinate module GET THIRTY-DAY

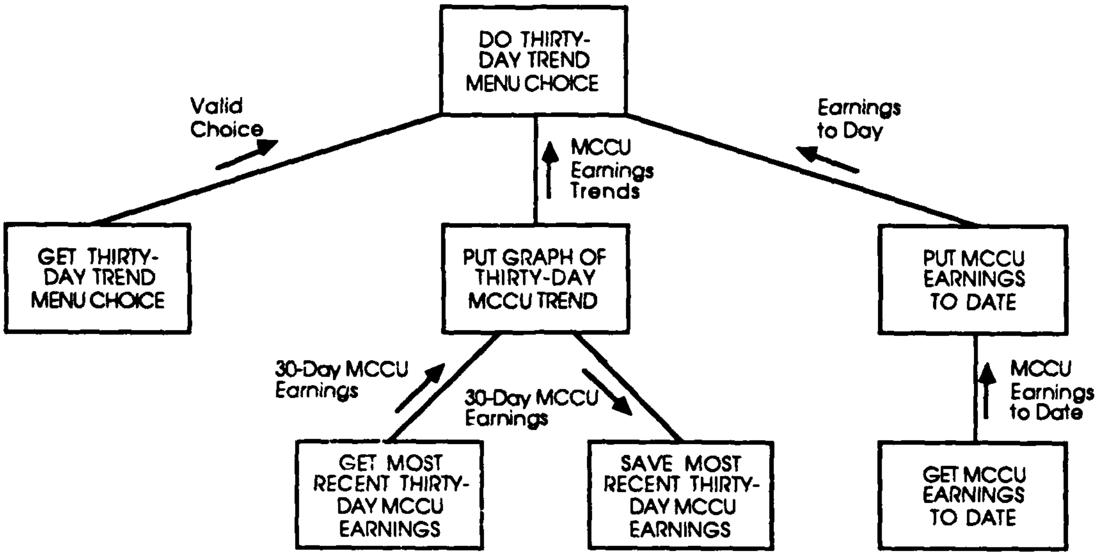


Figure 4-3. **Portion of Resource Management DSS Structure Chart**

TREND MENU CHOICE. This subordinate module will present the user with a menu, read the user's menu selection, check for valid input, and return the valid choice to the calling module (DO THIRTY-DAY TREND MENU CHOICE). Depending on the menu selection, this module will call upon either the PUT GRAPH OF THIRTY-DAY MCCU TREND module or the PUT MCCU EARNINGS TO DATE module. Supposing the former module is selected, the source code in this module will call upon the GET MOST RECENT THIRTY-DAY MCCU EARNINGS module, which will extract the most recent 30 days' worth of daily MCCU data and pass it back to the calling module, where the data will be graphed. This modularization breaks the entire system down into smaller portions, facilitating source code development. The remainder of the Resource Management DSS structure chart is found in Appendix H.

b. Module Specification By Module Specs

Examining the structure chart alone will not provide the needed information from which a programmer will be able to derive source code. An explanation of the

individual module by module specs must be provided to give sufficient information to the programmer [Page-Jones 80]. Pseudocode is the most often used form of module specs.

Pseudocode is a detailed method of describing a module that tells the programmer how the module will perform its function. It is written in a Structured English format and can look very similar to the code itself. Figure 4-4 provides a sample of the pseudocode found in Appendix I documenting the Resource Management DSS.

```
MODULE DO THIRTY-DAY TREND MENU CHOICE

  /* Finds out what the user wishes to do with MCCU earning trends */

  /* Narrows choices to displaying MCCUs earned to date, graphing
     recent trends, or quitting the menu */

     Get a valid menu pick

        If not quit then

           If      request for recent MCCU earning trends
                   then call module to graph thirty-day
                   MCCU trend

           Else    If request for MCCUs earned to date then
                   call module to display MCCU earnings
                   to date
END MODULE
```

Figure 4-4. **Sample Module-Spec By Pseudocode**

C. DECISION SUPPORT SYSTEM (DSS) ARCHITECTURE

The data, dialog, and modeling components of DSS architecture are also a convenient method of partitioning a DSS for design. The system specifically addresses the three major components of a DSS for designers to construct individual system requirements. The Resource Management DSS is described in this section by focusing on the data, dialog, and

modeling components. Each is described in detail and construction requirements are discussed.

1. Data Component

a. Description

The data needed to support the Resource Management DSS design will be extracted from a variety of reports and MIS in the hospital. At present, the proposed data extraction method consists of information systems personnel setting up the required databases in support of the the Resource Management DSS and assigning a database administrator. The context diagram of the DFD found in Appendix E identifies the different sources of necessary data. The database administrator will maintain the required databases to support the Resource Management DSS.

During the analysis phase, redundant sources of data elements were discovered. Many data elements identified in the locally generated reports were also found in the hospital MIS. The locally generated reports could be replaced by hospital MIS once data accuracy is verified. Using hardware to automatically extract data from the hospital MIS was not investigated for feasibility. The procedures and programs to perform the extraction of data are left for future research.

b. Construction

Four separate databases must be set up to support the first iteration of the Resource Management DSS: Two MCCU databases and two productivity databases will have to be established in order to provide a source of current MCCU and productivity information.

The first MCCU database, DAILY MCCU ANALYSIS FILE, will consist of MCCU earnings of the hospital each day for the current fiscal year. Daily MCCUs must be calculated and added to the database each 24-hour period. The maximum number of

days' worth of data will be 365 days and the minimum 30 days. In order to calculate the most recent 30-day MCCU earning trends, this database must have as a minimum the last 30 days' daily MCCU earnings on file.

The second MCCU database, MONTHLY MCCU ANALYSIS FILE, is composed of the entire hospital's monthly earnings of MCCUs for the current and previous fiscal years. As a maximum, this database will have 24 months of data and as a minimum it will contain 12 months of data.

The two productivity databases will require the past 24 months' productivity data by individual clinics as well as hospital-wide. The CLINIC PRODUCTIVITY ANALYSIS FILE will maintain the past 24 months' worth of productivity for each clinic in terms of monthly work units accomplished divided by the average number of health-care providers in the clinic that month. Productivity will have to be calculated and added to the database as the monthly totals become available. As another month is added, the oldest month can be deleted from the database.

The HOSPITAL PRODUCTIVITY ANALYSIS FILE will contain the hospital productivity values for the past 24 months in the same manner as the clinical database. The most recent 24 months' worth of productivity will be kept.

2. Dialog Component

a. Description

The importance of the dialog component cannot be overstated. If the interaction between the user and DSS is difficult, the DSS will most likely fall into disuse. The dialog component of the Resource Management DSS was analyzed in terms of user computer experience and estimated frequency of use. During interviews, levels of computer experience were discovered from potential users and a dialog method commensurate

with this skill level was determined. A menu-driven dialog was chosen that would guide the Resource Management DSS user through the different levels of the system.

The choice of a menu-driven dialog was made because this allowed resource managers not experienced with computers to easily learn and use the system. A menu-driven dialog will also alleviate the requirement of learning and relearning complex commands by infrequent system users and new users alike. The implementation of the Resource Management DSS should be flexible enough to use a menu-driven dialog combined with an interactive query type of dialog when necessary.

b. Construction

The menu-driven dialog will be constructed to provide a reasonable number of menu options (the magical number seven plus or minus two) so as not to overburden the user's capacity to process information [Miller 56]. A menu-driven dialog will guide the user through the various levels of the Resource Management DSS. Where appropriate, simple choices are selected from the menu, or the user is queried for input.

An example using the menu-driven dialog style is getting subjective predictions of future months' MCCU earnings. The menu-driven dialog will guide the user to the level of selecting the option of forecasting future MCCU earning trends based on the user's subjective predictions of the next two months' MCCU earnings. The system will query the user to input the next two, three, or four months' worth of MCCUs predicted by the user. The dialog component will read these inputs, check for validity, and project MCCU earnings a selected number of months beyond user predictions. At all menu levels, the option to exit the program will be available, as well as the option to return to previous menu screens where appropriate.

The use of case statements found in programming languages such as PASCAL will enhance the maintainability of the system. Modules responsible for

displaying menu choices and reading user selection can be easily changed by adding to or deleting from menu selections.

3. Modeling Component

a. Description

The modeling component of the Resource Management DSS architecture will be capable of giving the user a choice of modeling applications. For example, in the case of forecasting future monthly MCCU earnings, the user will be offered the opportunity to base the forecast on varying months of historic data or on varying months of user input predictions. Different lengths of future periods to be forecast will also be presented to the user.

The overall goal of the modeling component is to not force the user into a specific modeling construct. The user should be offered the opportunity to choose from several different types of models that best suit user needs. There is no sense in requiring the user to predict the next six months worth of productivity if only one month in the future is required. The priority will be getting the most accurate data analysis possible from the model base.

b. Construction

The construction of the modeling component will be such that a single model is represented by a module in the structure chart. This method will facilitate the use of different models for desired applications and allow changes to existing models or additions of new ones. Future iterations should allow the user to identify the need to use a general type of model and allow a search of the model base for a specific application the user requires. A model base consisting of many useful models will enhance the usability of the system. The Resource Management DSS will possess the characteristics of a tailor-made system, aiding users in finding and applying appropriate models.

D. SUMMARY

The main thrust of this chapter was to take a portion of the Resource Management DSS from the analysis phase into the design phase. This chapter identified the first iteration of the system to be designed, transformed the analysis into design using structured and module specification methods, and described the architecture of the Resource Management DSS.

The structured specification describes the logical design of the system using the data flow diagram (DFD). The DFD presents a graphic description of the overall system, taking the view down through several layers. Mini-specs aid in further describing this graphic presentation.

The module specification phase takes the documentation from the structured specification phase and further describes the developing Resource Management DSS. The module specification describes how the system was to perform desired functions using the structure chart and module specs. From these two by-products of the module specification, follow-on researchers will easily produce source code to implement the first iteration of the Resource Management DSS.

The final section of this chapter discussed the actual construction of the three DSS architecture components which were described in Chapter II. Within the data component, the four databases required for the first iteration of the Resource Management DSS were described. The dialog component was designed to guide the user through the different levels of the system by using a menu dialog interaction between user and system. The last DSS architecture component, the modeling component, was designed to use separate modules within the source code to perform desired modeling functions on extracted data. As the Resource Management DSS develops, a model base will allow the user to choose from a variety of models.

It must be emphasized the design presented in this chapter is for Version 0, the first of many iterations through which the Resource Management DSS must pass prior to becoming the ultimate system envisioned by both user and builder. Continuous interaction between user and builder will serve to enhance the effectiveness of the Resource Management DSS and, as a result, enhance the effectiveness of the quality of decisions made by upper-level managers at SBHACH.

V. SUMMARY OF RESEARCH AND RECOMMENDATIONS FOR FUTURE STUDY

The thesis research presented in the previous chapters documented the development of the Resource Management Decision Support System (DSS) from inception to design. The need for a computer-based system to aid Silas B. Hays Army Community Hospital (SBHACH) resource managers was discussed, and methodologies for identifying critical information needs of decision makers were presented. Data was collected through structured interviews and analyzed in order to derive the hospital's Critical Success Factors (CSFs). Finally, proposed measures were discussed that would give decision makers the ability to analyze data necessary to satisfy identified CSFs and the first iteration of the Resource Management DSS was designed.

A. SUMMARY OF RESEARCH

This section of the thesis emphasizes the important factors discovered during the course of the thesis research. The areas briefly discussed are the methodology used to derive SBHACH CSFs, the design of the first iteration of the Resource Management DSS, the value of the thesis research, and the suggested implementation procedure for the Resource Management DSS.

1. Derivation of CSFs

The methodology used to derive CSFs from SBHACH resource managers was the structured interview. Six upper-level managers were interviewed. The data collected during interviews was used to develop the individual managers' CSFs. Summaries of the interviews are found in Appendix C.

The next step in determining the hospital's CSFs was to move from a manager's focus of CSFs to an organizational focus. As discussed by Bullen and Rockart, the individual CSFs are aggregated and from this compilation organizational CSFs are derived [Bullen 81]. Each manager's CSFs were analyzed and a master list of prioritized CSFs for the hospital was derived. Once organizational CSFs were listed, proposed measures that a computer system should possess to satisfy CSFs were developed. Table 5-1 summarizes the four CSFs derived from the research and presents the proposed measures to satisfy these organizational CSFs for SBHACH.

TABLE 5-1

CRITICAL SUCCESS FACTORS AND PROPOSED MEASURES

	Critical Success Factors	Proposed Measures
CSF 1	Maintain sufficient fiscal resources to meet the demands for inpatient and outpatient health-care services.	• Compare current clinic work unit levels to historic values. • Forecast future clinical productivity using historic data and user-projected values. • Forecast future hospital productivity using historic data and user-projected values. • Compare current MCCU data to historical data and projected goals. • Project future MCCU values based on current trends of MCCU earnings and user-projected values. • Calculate unused capacity in the form of bed space and potential discharge information. • Calculate projected bed space required based on current trends.

TABLE 5-1 (Continued)

CRITICAL SUCCESS FACTORS AND PROPOSED MEASURES

	Critical Success Factors	Proposed Measures
CSF 2	Maintain sufficient military and civilian personnel to adequately provide health-care services to fluctuating inpatient and outpatient levels.	• Project gains/losses for six months in the future for military and civilian personnel. • Forecast clinical staffing levels from historical data and user-projected input. • Compare different clinical productivity levels at the same time.
CSF 3	Monitor the impact of the Primary Care to Uniformed Services (PRIMUS) clinics and the Civilian Health And Medical Program of the Uniformed Services (CHAMPUS) reform initiative.	• Measure the daily fluctuation of clinic productivity in work units compared to historical values. • Forecast the number of outpatients in the future based on historical referrals from the PRIMUS clinics. • Measure the daily fluctuation of clinic MCCUs earned compared to historical values. • Project trends of outpatient drops due to loss of outpatients to PRIMUS.
CSF 4	Maintain a sufficient amount of medical equipment, in proper working order, to provide necessary health-care services to inpatient and outpatient demands.	• Forecast future monthly budget expenditures on capital equipment based on historical data. • Forecast future monthly budget expenditures on capital equipment based on projected user input.

2. *Design of First Iteration*

The methodologies used to design the first iteration of the Resource Management DSS were the structured specification and the module specification. Figure 5-1 illustrates the use of these two methodologies producing documentation from which further

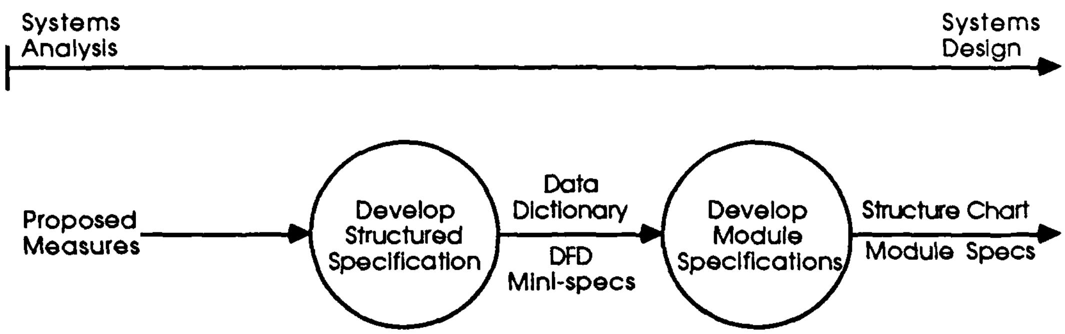


Figure 5-1. Transitions From Systems Analysis to Systems Design

design is conducted, stopping short of source code development. The proposed measures developed from the CSFs are analyzed and the data flow diagram, mini-specs, and data dictionary are developed from the structured specification.

Further design is conducted by using output of the structured specification phase as input to the module specification phase. Finally, the structure chart and module specifications are developed. From these five outputs of structured design, the Resource Management DSS for SBHACH may be implemented. The documentation found in Appendices E, F, G, H, and I is used to describe the Resource Management DSS in terms of the data, dialog, and modeling components found in Figure 5-2. The databases for the Resource Management DSS are identified in the data component, and the different dialog styles and models used are listed in the dialog and modeling components.

During the structured design phase, four databases were identified that will need to be established in order to support the Resource Management DSS. Data extracted from various reports and MIS (see Figure 5-2) will be put into these four databases. The two MCCU databases will supply data to graphically illustrate recent and historic MCCU earning trends. The clinic and hospital monthly productivity databases will be used to analyze both individual clinic and hospital productivity values over varying time periods.

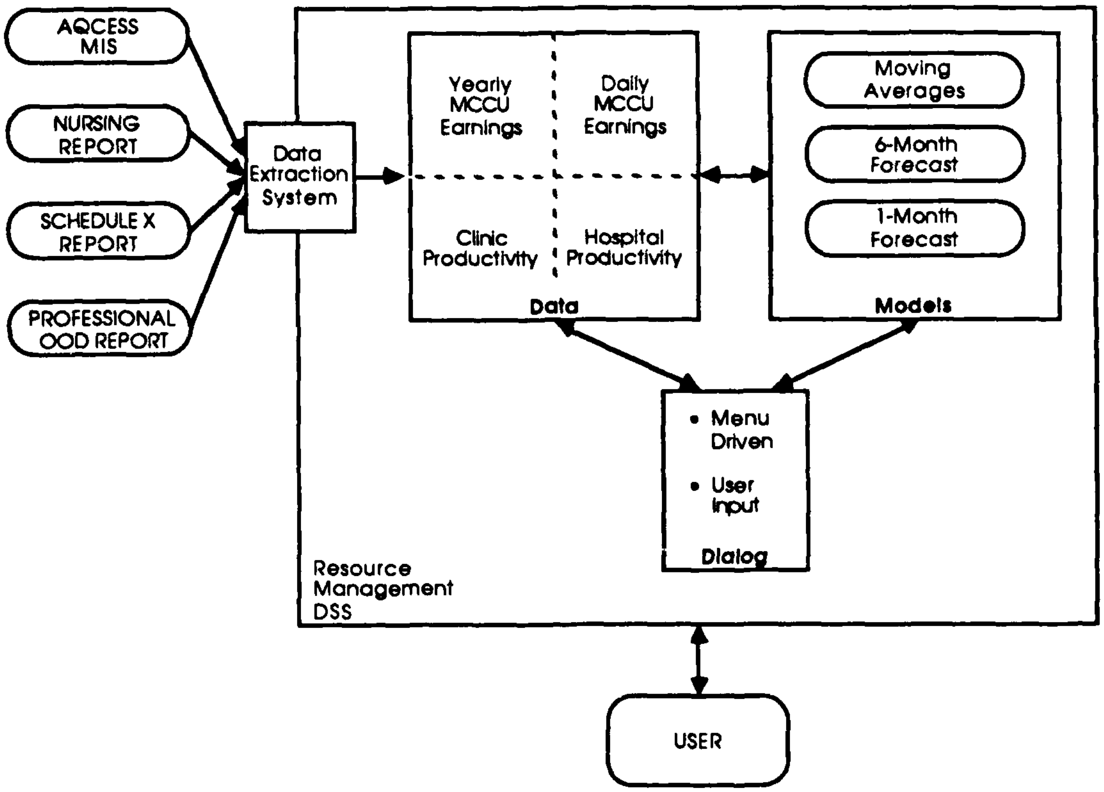


Figure 5-2. **Resource Management DSS Components**

The dialog component for the Resource Management DSS will provide the capability of guiding the user through various levels of menus in order to view required data. The menu-driven dialog was chosen as the method of communication between user and system due to the ease of interaction and, more importantly, because this specific method supports novice computer users and infrequent users alike. Making the dialog component simple to use stresses flexibility in allowing various managers to use the Resource Management DSS and accommodates the frequent job changes found in most military environments.

The most important aspect of the modeling component was the development of a model base type of management system. As the Resource Management DSS is implemented, different models will be added to the system and existing ones will be modified.

The modeling component of the Resource Management DSS is built to incorporate a single model within a module of source code. This flexibility will allow system maintainers to make modeling changes easily.

3. Value of Research

The research conducted will primarily aid upper-level managers at SBHACH. Once implemented, the Resource Management DSS will provide resource managers the ability to analyze relevant data for ill-structured decision problems commonly found in the hospital administration field and manipulate this data in different manners. The overall value of the research will ultimately be the improved decision-making quality the Resource Management DSS will lend to upper-level managers at SBHACH. The design of the Resource Management DSS proposes timely access to relevant data that was not available prior to this research. The added capability of manipulating data in various ways will allow the system users to make ad hoc queries into different databases and ask "What if?" questions when required.

4. Implementation Procedures

The logical next step of developing the Resource Management DSS is to implement the system by writing source code and to deliver the system to the users for review. The system documentation developed in the design phase should be sufficient for the easy development of source code. The decision must be made as to which programming language will be used. It is possible the first iteration could be developed in more than one programming language and results compared.

Once the first iteration is implemented, the delivered product should be delivered to the user for review. After getting user feedback, the first iteration could be built on to include user changes and proposed measures to satisfy more of the first CSF as well as

other CSFs. This iterative process will foster the evolution of a DSS that truly reflects SBHACH user requirements.

B. OPPORTUNITIES FOR FUTURE RESEARCH

The research presented in the thesis represents the first of several iterations that will be conducted before the Resource Management DSS evolves into a fully functioning Decision Support System. During the course of research, some areas were identified that may lead to future research; automating the data extraction task and defining the tasks of the database administrator are two examples.

1. Data Extraction

There is no automated data extraction method that extracts data from the various sources in the hospital. The different MIS at the hospital provide data as well as the previously identified reports (see Figure 5-2). Further research in this area could identify which data sources provide the most accurate data and discover methods of extracting data automatically from the various MIS in use at the hospital. Adding modules to the commercial MIS was ruled out due to violating commercial contracts with system maintainers. Detailed studies might identify methods of extracting the data from the different MIS without violating these commercial contracts.

2. Establishing Duties of Database Administrator

The intention of the hospital is to implement a local area network with terminals provided to key resource managers within the hospital. The Resource Management DSS is one of several software packages that will be used on the network (electronic mail would also be included). Further research could identify the duties and operating procedures of the assigned database administrator of the local area network. This research would be instrumental in establishing and maintaining the many databases that will be created by future iterations of the Resource Management DSS.

APPENDIX A

INITIAL FACT-FINDING INTERVIEW

A. DESCRIPTION

This appendix summarizes the initial interview conducted on 1 March, 1988, by the author to discuss information management problems at Silas B. Hays Army Community Hospital (SBHACH). Attendees were the Chief of Resource Management Division and the Chief of Clinical Support Division. Names of the resource managers holding these billets have been omitted though nothing inappropriate was discussed.

An important point the interview brought out was the current method the Department of Defense (DOD) uses to reimburse health-care services provided by SBHACH. The current system, Medical Care Composite Units (MCCUs), was described as archaic and difficult to use by resource managers. The major problem of the MCCU method is that it does not provide a breakdown by operational department that may be used by managers as a monitoring tool. The feedback from DOD is a lump sum by quarter of what each Medical Treatment Facility (MTF) has earned.

The ideal system the interviewees described would separate "winners" from "losers" in terms of outputs to inputs. Managers want the ability to analyze each operational department and determine if the outputs in the form of health-care services rendered are equal to the number of MCCUs earned. They also summarized in the interview the other areas of information management they wanted the proposed system to provide.

B. SUMMARY OF INTERVIEW

The purpose of the meeting was to identify what requirements upper-level management (Hospital Commander and Executive Officer) wanted from existing information systems and what could be done to solve information needs.

They noted that due to budget constraints, managers at SBHACH were essentially forced to make use of existing Management Information Systems (MIS), i.e., no funding was available for a new MIS. Given this, they want the development of some method for identifying "winners" and "losers" in terms of the operational medical departments in the MTF. He explained that Medical Care Composite Units (MCCUs) are how the DOD allocates budget funding to Medical Treatment Facilities (MTFs). They next described in detail the current method the MCCU system used to earn DOD reimbursement for SBHACH. When health-care providers (doctors, nurses, lab technicians...) provide services to patients in the form of consults, surgery, pharmaceutical prescriptions, bed space, x-rays, and other varied services, the hospital is credited with MCCUs depending on the type of service. For example, an outpatient visit is worth 0.3 MCCUs, a live birth is valued at 10 MCCUs, and an admission is worth 10 MCCUs the first day and 1 MCCU every day thereafter.

Data that determines the number of MCCUs provided is maintained daily on an information system called the Uniform Chart of Accounts Performance Expense Reports System (UCAPERS). This data is input by type and cost of service provided. The information is updated daily, and monthly a tape summarizing all health-care services provided is sent to a DOD run facility that calculates the data into MCCUs. This data, in the form of MCCUs, is then used by DOD personnel to provide monetary funding to SBHACH in reimbursement for health-care services provided at the hospital. A hard-copy

report comes back to the hospital summarizing the previous quarter by the amount of MCCUs the entire MTF earned.

They acknowledged the MCCU method is archaic. The financial benefits are in direct conflict to modern medical treatment practices; for example, the hospital will get more "points" for admitting a patient than for treating him/her as an outpatient.

They next pointed out that the information they want is supplied in part on two of the MIS in the hospital, UCAPERS and the Automated Quality of Care Evaluation Support System (AQCESS).

"Winners" are those departments that provide health-care services which earn an MCCU value equal or greater than services expended. "Losers" are those health-care services which are provided and either do not earn an equal amount of MCCUs or are not reimbursable. They noted that generally an admission into the hospital and a stay of over four days represented a loss of MCCUs to the hospital after the fourth day. The problem for resource managers is they cannot dictate that medical services above a certain threshold will not be performed. The specialists would lose their expertise and, more importantly, there would be tremendous social ramifications in denying medical services. They pointed out that even though hospital managers have a general idea of the financial position the hospital is in, the feedback from the MCCU method is not timely (quarterly basis) and may conflict with management estimates.

The system they envision would provide reports at least on a quarterly basis and would provide the following information:

- Identify by department and/or physician the workload performed;
- Show which health-care services performed are reimbursed in terms of MCCUs;
- Show which services are not reimbursed;
- Use outputs to monitor progress of departments which are financial sinks;

- Use outputs to recognize departments which are performing well.

The last part of the meeting was spent identifying specific data that should be incorporated into the DSS. Table A-1 summarizes the type of measurements upper-level management was looking for.

TABLE A-1

QUANTITATIVE MEASURES REQUESTED BY UPPER-LEVEL MANAGERS

Inpatient Revenue/patient day	Outpatient revenue/visit
Number of admissions	Census (number of beds)
Length of stay	Mean hospital salary
Mean hospital salary for community	Wage expenses by department
Hours worked by department	Supply expenses by department
Number of unfilled positions	Turnover rate
Absentee rate	Nursing work hours/patient day

In addition to the requirements in Table A-1, they also mentioned that it would be convenient to have a measurement of the average clinic waiting time for a patient, loss of workload due to unused health-care provider capacity, and the number of unused appointments.

APPENDIX B

STRUCTURED INTERVIEW FORM

I. DESCRIPTION

This appendix contains structured questions for the conduct of interviews at Silas B. Hays Army Community Hospital (SBHACH). Questions were developed to determine management Critical Success Factors (CSFs) [Bullen 81, Rockart 79, Rockart 82, and Rockart and Treacy 82].

II. QUESTIONS USED IN INTERVIEWS

A. Industry

1. In what areas will a failure hurt you the most in your job?

B. Competitive Strategy and Industry Position

1. How do you view your job and the organization as a whole? Do you function as a caretaker or strategic planner?
2. What are your formal and informal operational goals over the next 12 months?
3. What information do you need to maintain Silas B. Hays in the position of a competent provider of health-care services? Do community factors affect you? If yes, how much are you affected by the community?

C. Environmental Factors

1. What information is necessary for managing resources in the health-care industry?
2. What budget constraints do you face in your job?
3. Are there certain health-care services that are not economical to fund?
4. How do changes in patient levels affect your job?

D. Temporal Factors

1. What current problems demand your attention now?
2. What latest crises are you addressing presently?

E. Managerial Position

1. What is your role in the overall organization?
2. What information do you need to perform your job?
3. Where do you get this information from?
4. What kinds of information are you asked to calculate, process, and present the most?
5. Is the data readily available in the form you need or does it need to be processed? If yes, how much processing is necessary?
6. Do you require mostly current data or historical data in your job?
7. What techniques do you use to solve the biggest problems confronting you? Where do you go to find the information necessary to do this?
8. Do you get information you need fast enough?

F. Internal and External Factors

1. What areas affect your job the most that you are unable to control?
2. In the areas that you can control, what items do you find a need to control the most?

G. Monitoring and Building Factors

1. What best describes your job? Is it a function of monitoring by reporting findings to seniors or do you do more planning by looking at trends and forecasting future developments and requirements?
2. What are the most important things to find out when you come back from an extended leave or TDY period?
3. What methods do you use to measure success or failure?

4. What kind of soft data do you like to know? Do you rely on word of mouth, rumors, personal observations of staff, or other soft inputs?

APPENDIX C

SUMMARY OF CRITICAL SUCCESS FACTOR INTERVIEWS

A. DESCRIPTION

This appendix summarizes the six interviews conducted with senior resource managers at Silas B. Hays Army Community Hospital (SBHACH). These interviews were used to develop organizational critical success factors. A separate interview summary is provided for each resource manager interviewed. The interviews are presented in the order in which they were conducted. Names of the resource managers holding the billets have been omitted though there is nothing inappropriate in any of the interviews.

B. SUMMARY OF INTERVIEW WITH THE NURSING METHODS ANALYST

The Nursing Methods Analyst works in the Resource Management Division. The job she is performing is a follow-on tour after receiving a Master of Science in Nursing Administration.

1. Industry Factors

The Nursing Methods Analyst pointed out that SBHACH does not have a charter narrowly defining goals and objectives, so it was difficult for her to define industry factors that affect her job. This motivated her to explain that the hospital is responsible for satisfying those general health-care requirements that active duty, dependent, and retiree personnel need. Proper health care to this population in the surrounding community was first and foremost in the hospital's objectives.

2. Competitive Strategy and Industry Position:

She described the overall strategy of SBHACH as providing support to inpatients over outpatients and the staffing of the workcenters that provide direct patient support over those that provide administrative support.

3. Environmental Factors

There are certain factors in her job over which she has no control. She depends on reports from which she extracts data from to generate her own reports. This aspect of her job was considered frustrating because she could not control the timing, accuracy, or flow of this information.

She went on to point out that the Hospital Commander required the hospital to provide certain types of health-care services that are losing propositions. For example, the neurology clinic does not see enough patients to justify its presence in the hospital, yet the Hospital Commander has decided to continue this support in order to satisfy sporadic community needs. Closing this clinic and similar nonproductive clinics would have a negative impact on the reputation of the hospital.

Another important source of outside influence comes from the Health Services Command (HSC). For example, HSC has dictated to all Medical Treatment Facilities (MTFs) that they provide two areas of support in AIDS testing. Fenced budget allocations are provided to test active duty personnel at Fort Ord for exposure to the AIDS virus. This includes documenting the results and providing counseling and follow-on medical services for active duty members exposed to the virus. The second initiative in the AIDS arena is to require testing of all active duty inpatients and to strongly suggest testing for dependent and retiree inpatients. The purpose is to identify any inpatients who may carry the AIDS virus so health-care providers can take appropriate preventive measures while working with body fluids.

4. Temporal Factors

She discussed two temporal factors affecting her job: the implementation of the Automated Quality of Care Evaluation Support System (AQCESS) and getting a reporting system accepted that she has developed to report on clinic productivity.

The AQCESS system used to require an inordinate amount of her time monitoring the progress of implementation and transition to users at the hospital clinics. This system, developed by contractors, gave individual clinics appointment scheduling capability to ease the burden on the crowded centralized scheduling system. The "bugs" are slowly being worked out of the system and, as time passes, it requires less of her time.

The factor on which she spends the majority of her time is a productivity report she is attempting to get accepted as a monitoring tool. The developed report satisfies the major information needs in her job—how to measure output of individual clinics for better civilian and military personnel staffing.

She described the mechanics of extracting the data from other reports and databases in order to generate her final product, which is presented to the Chief of Resource Management Division. On a monthly basis, clinics hand-prepare a 310 Report which identifies by health-care provider the number of total work units he/she has earned the past month. The monthly work unit average is then calculated for the clinic. It is important to note that a work unit depends on the type of health-care service being rendered—it may be x-rays taken, patients seen, pharmaceuticals dispensed, or some other dictated method from HSC. The 310 Report is then forwarded to the Resource Management Division.

She further explained that administrative personnel in her division enter this work-center data into a database going back two years. This database contains a summary of the 310 Report in the form of a Running Schedule X Report. The Running Schedule X

Report maintains by clinic a monthly running total of work units earned, staffing strength, and work units earned by personnel not part of the paid staff (volunteers, Red Cross personnel, etc.).

She explained she next extracts data from both reports to make her Productivity Report. Her report takes average work units earned by each clinic for the month and the average staffing of clinics excluding non-payroll volunteer work, and compares these two factors with the number of staff HSC has determined will be assigned to the clinic. The final product is input to a Lotus 1-2-3 software package that summarizes, by month, average staffing levels and work units performed. This information is used primarily as a monitoring tool that compares clinic output with staffing levels. With this information, resource managers can look at a particular clinic over a period of several months and verify that with additional staffing a clinic has provided more work units, as would be expected. This tool can also identify negative trends, such as additions to staffing and no significant increase in work units provided or even a reverse output trend.

Ultimately, this report is used to directly affect civilian hiring and reallocation of military personnel. Often she is asked to analyze the impact of reducing clinic staffing levels. She sees this Productivity Report as an essential tool in performing her job.

5. Managerial Position

She views her job as a staff officer, providing input to the Chief of Resource Management Division on any aspect of the hospital that is required. She is called upon to perform any catch-all job that does not fall within other job descriptions and deals with resource management monitoring. Her job deals with administrative issues affecting nursing, patient care, and patient complaints. An example she pointed out would be the investigation of whether a new inpatient ward or clinic should be opened. She would assess the impact this venture would have on overall goals and objectives of the hospital.

As described earlier, she needs data from a varied number of Management Information Systems (MIS) currently in operation. She works predominantly with historical data and some current data to project workload trends in the future. The data she does use requires a great deal of processing by her staff into a form that is usable for presentation to decision makers.

6. Internal and External Factors

The only factor she wished she could control is the method HSC uses to dictate the amount of staff to be assigned to a clinic. She explained that in a few clinics, the number of health-care providers authorized is based on an uncontrollable factor such as the civilian population in the surrounding geographical area. This arbitrary authorization of staff to a clinic sometimes frustrates resource managers when they attempt to reallocate health-care providers in contrast to HSC guidance.

7. Monitoring and Building Factors

She predominantly is concerned with monitoring output from clinic and ward staffing levels and reporting trends to the Chief of Resource Management Division. She explained this area of her job is most important for her success or failure in the Resource Management Division. From the information provided through her Productivity Report, the Chief of Resource Management Division can make educated decisions concerning staffing levels throughout the hospital.

C. SUMMARY OF INTERVIEW WITH THE CHIEF OF PATIENT ADMINISTRATION DIVISION

The Chief of Patient Administration Division works directly for the Deputy Commander for Administration. He took over the job only four months ago.

1. Industry Factors

He could identify one factor about which he is most concerned within the Patient Administration Division. His work center is responsible for all inpatient records and birth and death information. The accuracy and confidentiality of this data is vitally important to his job success. He therefore staffs his work centers accordingly. He assigns quality personnel to the record-keeping work centers over the more mundane ones such as word processing.

2. Competitive Strategy and Industry Position

He viewed his job as more a caretaker than a strategic planner. He felt that a mismanaged Patient Administration Division can significantly slow a hospital's internal functioning as well as destroy its credibility with erroneously reported births and deaths. For this reason, an officer capable of dealing with all aspects of administrative reporting is required to closely supervise accurate administrative documentation.

He pointed out that one of his informal goals in the next 12 months was to get his workcenter's staffing level back to a level he feels comfortable with. At this time, he has several vacant positions in the medical records section, and if these positions are not filled quickly it may affect the accuracy and confidentiality issue.

3. Environmental Factors

He explained that fluctuating patient levels had the most significant impact on his job. When patient levels increase dramatically, his staff is flooded with Civilian Health And Medical Program of the Uniformed Services (CHAMPUS) requests and associated paperwork. SBHACH has approximately 125 beds for inpatients. When this space approaches full capacity, his staff has difficulty in keeping up with the administrative paperwork such as surgery narratives, check-in/check-out functions, birth/death certifi-

cates, and workload summaries for all work centers. He stated, "If the hospital closed down today, we would finally finish our job about two weeks later."

4. Temporal Factors

He identified two temporal factors affecting him now: the two Primary Care to Uniformed Services (PRIMUS) clinics being opened at The Presidio of Monterey and Salinas, California, and the CHAMPUS Reform Initiative.

With the opening of the two satellite PRIMUS clinics, his staff will provide administrative support by maintaining health records initiated by the civilian funded programs. When patients are treated at these satellite locations, his staff will provide periodic audit services and correct administrative defects discovered.

The CHAMPUS Reform Initiative is a program sponsored by the HSC to retard the yearly costs of CHAMPUS, which currently are rising at a rate of 25 percent a year. In effect, the purpose of the CHAMPUS reform initiative is to identify a number of health-care providers outside the military hospital system who can provide medical care for the overflow of patients at SBHACH. Using these health-care providers under contract will cost the government less in CHAMPUS costs than the current method of using outside medical practitioners. He will be required to provide administrative support to the team that will be setting up the new CHAMPUS system in the surrounding community.

5. Managerial Position

He does very little information management in the hospital. He identified his work center as a source of one feeder report which resource managers use. The monthly Workload Report is a summary of data obtained from the AQCESS MIS and provides a breakout by clinic and health-care provider of the workload accomplished over a given period of time. This report functions as a monthly database and is forwarded to the Resource Management Division, where data is extracted to generate a number of reports to

monitor clinic productivity. A spin-off of this report calculates the number of Medical Care Composite Units (MCCUs) the hospital has unofficially earned for resource allocation. The MCCU estimation is used by administrators to monitor the individual clinics.

6. Internal and External Factors

He reiterated that he is affected externally by the patient levels and cannot react to this fluctuation easily.

7. Monitoring and Building Factors

He monitors his staffing levels very closely. He noted that if certain key positions remain vacant for extended periods, he will assume the job is not being done as efficiently as possible and takes appropriate quality assurance action to inspect output and make necessary corrections.

D. SUMMARY OF INTERVIEW WITH THE CHIEF OF PERSONNEL DIVISION

The Chief of Personnel Division works directly for the Deputy Commander of Administration. He has been in the current job for over a year and moved up from other assorted administrative jobs in the hospital.

1. Industry Factors

He identified one major health-care industry factor that affected his division. He pointed out that the hiring of civilian personnel was always at the forefront of his attention. The Department of Defense (DOD) hiring freeze especially affects the hospital in the large number of vacant positions.

2. Competitive Strategy and Industry Position

He viewed his job as 90 percent caretaker and the remainder as a strategic planner. He described his job as maintaining personnel records support for all military and civilian personnel working within the hospital.

The military personnel have their records maintained on a local MIS called Standard Installation Divisional Personnel System (SIDPERS), which feeds the Fort Ord SIDPERS database. The information is kept on over 15 fields of data elements, including rank, social security number, name, date of birth, and other miscellaneous personal information that would be kept by administrative and record-keeping personnel.

His people are responsible for maintaining the accuracy of these records, making changes as personal information changes for assigned personnel, and adding new arrivals and deleting transfers. Some data fields are protected, such as the grade and pay fields. All other fields may be updated and updates are then sent to the database on post. Any pay upgrades are hand-routed to the database on post and the changes are reflected in a short time.

He uses this database to view the information in different ways to answer queries that come up during the course of business. A sample question might be "How many enlisted troops are working at the hospital who have a rank over E-5 and are single?" Although SIDPERS provides an ad hoc query function that allows users to view the database, it is limited in scope. He noted that questions arise that are answered by manually combining both SIDPERS and other databases and hand-sorting personnel records. In these cases, a method of viewing this data in some relational format would greatly enhance the Personnel Division. He noted that the amount of time spent on accessing the database was 70 percent ad hoc and 30 percent for routine queries.

One of the short-term goals on which he is working is the maintenance of military health-care providers' qualification records for going into combat with the rapid deployable forces. Health-care providers (corpsmen, doctors, and nurses) are assigned to deployable units and qualifications must be met in order for them to go into combat with the ground units when they deploy. The qualifications record-keeping is a major task for him

and his staff. Some of the data fields are maintained by SIDPERS and some are maintained manually. He would like to implement some system that could use SIDPERS data elements along with others in a relational database. It is vitally important for health-care providers to have up-to-date qualifications in order to go into potential combat situations. The system he envisions would automatically flag personnel whose qualifications have expired or will expire prior to the next scheduled training cycle.

An important part of his job is maintaining staff levels of both military and civilian personnel. The hospital is authorized only so many military health-care providers, and the remaining positions are filled by civilian employees. In the event of budget cuts, it is necessary to reduce the number of civilians and/or freeze the hiring rate. When this happens, the remaining military must work longer shifts and military personnel assigned directly to ground units must be pulled back to the hospital to augment the staff until relief in the form of reduced workload or civilian hires is accomplished. As shortages exist within the hospital in civilian employees, a committee consisting of managers meets as needed to decide on the hiring for departments that are understaffed. A critical information requirement is some sort of quantitative tool to determine which departments are in the greatest need for new employees.

3. Temporal Factors

The only temporal problem he sees at this time is the budget situation. The state of the budget has caused a hiring freeze on civilian employees. At this time, military personnel have been jockeyed around and shift hours have been expanded to handle this crisis. There is not much anyone at the hospital can do to alleviate this, but they can ensure that military health-care providers moved within the hospital or added from the outside as augmentees are done so in an intelligent manner. In other words, clinics and wards that need

people most get these people, and the impact of reassigning an individual within the hospital is investigated fully.

4. Managerial Position

He functions as a staff officer who maintains up-to-date information on military and civilian personnel. He accesses two MIS to maintain records on the hospital work force. On the military side, he is the troop commander responsible for maintaining good order and discipline as well as promotions. For the civilian workforce, he is responsible for recruiting and hiring when the need arises. The Uniform Chart of Accounts Performance Expense Reports System (UCAPERS) provides information on civilian health-care providers, and the SIDPERS system maintains files on military personnel.

If the military work force is experiencing a shortage, he is required to deal with the next level of command to get new personnel assigned to SBHACH. If it is the civilian work force that is short, the committee decides on what job description is required and he is responsible for advertising and hiring.

5. Internal and External Factors

The dominant factor in his job is to ensure that the work force is maintained at the level necessary to provide competent health care to patients. Even if this goal is to be performed at the expense of administrative functions, it must be done. Since his division is primarily administrative in nature, he is prepared to sacrifice human resources for the more important clinics.

6. Monitoring and Building Factors

In order to answer questions concerning staffing levels and hiring rates, he must do a great deal of ad hoc questioning of his staff. The information he requires is not always readily available and requires him to search out the necessary data to make decisions.

He always monitors the unit discipline and reassignment of personnel within the hospital. He needs to continuously know any changes to staffing levels in order to keep the commander apprised of changes that will affect patient treatment.

E. SUMMARY OF INTERVIEW WITH THE DEPUTY COMMANDER FOR ADMINISTRATION

The Deputy Commander for Administration at SBHACH is responsible for all administrative matters within the hospital and reports directly to the Hospital Commander. Prior to taking this post at Fort Ord, he served in a smaller hospital overseas, where he performed a similar job.

1. Industry Factors

The information area he feels the hospital needs the most is timely, accurate information. He requires information on earned MCCUs and compares this figure to output spent by the individual clinics and wards. Areas that get the hospital in trouble are spending more on output then is earned through health-care services provided and the slow method of calculating MCCUs earned by the hospital.

2. Competitive Strategy and Industry Position

He described his job as being both a monitor and strategic planner, but more towards monitoring tasks. He functions as a staff officer to the Hospital Commander and provides the commander with information on administrative functions.

He identified two primary goals he is attempting to accomplish within the next 12 months. He is trying to market the nursing positions at the hospital and increase the productivity of the individual departments through education and training.

There is a civilian nursing shortage at SBHACH. The hospital is authorized to pay civilian nurses at a given rate, but the surrounding community is paying their nursing staff at a much higher rate. Therefore, it is difficult to attract nurses to SBHACH. The

method he is using to solve this problem is to increase the productivity of the hospital, earn more funding for the hospital through this increased productivity, and take the funding and augment salaries of the civilian nursing staff in order to attract and maintain needed nurses. Normally, excess funds would be turned into HSC for reallocation. However, he has struck a deal that allows him to use these funds for civilian nursing and some capital equipment.

3. Environmental Factors

He is concerned with the effect the two PRIMUS clinics that are being opened near Fort Ord will have on the hospital. The PRIMUS clinics were designed to provide health care to active duty, retired, and dependent personnel as an alternative to the medical treatment also provided at SBHACH. The medical care is provided by mostly civilian personnel under contract and covers small injuries, common illnesses, and general medical problems. Although the two PRIMUS clinics will duplicate a percentage of medical care that is already provided at SBHACH, there are certain medical services not provided. SBHACH will still offer all medical services, but the PRIMUS clinics will take some of the workload from the hospital and give additional medical care to the surrounding military community. The PRIMUS clinics can have three effects on the hospital: They may attract patients away from the hospital and cause the overall hospital productivity to drop, they may increase the amount of patients treated through patient referrals, or the patient levels may remain the same.

Another identified environmental factor that affects the hospital is the lack of control over military construction. Military construction is provided locally from the base and the hospital has little control over it from the standpoint of pushing projects through to completion that they deem as the most important. He cannot contract out specific projects to be completed and must rely on the post to provide this support.

4. Temporal Factors

He identified a number of temporal factors with which he is dealing at SBHACH. The most important factors are how the PRIMUS clinics and the CHAMPUS reform initiative in combination will affect the workload at the hospital. Hospital administrators are waiting to see how the workload will fluctuate before taking action to address these factors. An action officer has been assigned to monitor this factor.

5. Managerial Position

He described his managerial position as one of evaluating performance. He constantly monitors the levels of clinic productivity, patient levels, and consumption of resources in treating patients. He gets most of the information he needs from the Productivity Report supplied by the Resource Management Division that identifies a variety of information, including the capacity of each ward and the status of the nursing staff.

He relies heavily on the earned value of MCCUs throughout the hospital. He needs to know the current earned value of the hospital's MCCUs in relation to the established goal set by his office. Unfortunately, the exact number of MCCUs earned to date is accurate to only ten days prior to the present date. If he wants the exact number of MCCUs earned to date, it takes about ten days to compile this figure for use.

6. Internal and External Factors

One of the areas that affects his job most that he is unable to control is the cyclic nursing problem. As nursing levels drop due to fewer nurses hired at the hospital, patient levels drop because there are not enough nurses available to staff hospital wards, and as a result the hospital's productivity declines. Higher headquarters sees this decline in productivity, determines that the hospital has excess capacity, lowers the amount of nurses allowed to be hired, and the cycle then repeats.

7. Monitoring and Building Factors

He stated that his job is primarily a job of monitoring the input, output, and budget expenditures of the hospital. He is concerned with significant budget decisions and patient levels. He uses the MCCU method as a monitoring tool to measure the success of a specific ward within the hospital. The goal for the hospital is to earn 780 MCCUs per day and spend $24 worth of resources on each MCCU earned. Currently, the hospital is earning 840 MCCUs per day, and spending $18 worth of resources for each MCCU earned.

The profit the hospital is generating is used to provide salary incentives to attract and maintain an appropriate nursing staff level within the hospital as well as to purchase equipment that is at the forefront of certain medical technologies to provide the latest health-care possible.

He maintains a monthly statistic report that follows each clinic and provides a breakdown of current monthly admissions, average daily admissions, and an optimal admission goal established for each clinic based on spending $20 on resources per MCCU. With this report, he can easily see which clinics are ahead or behind their optimal goals and take corrective action. Unfortunately, this report is only a snapshot at one particular time during the month and the information becomes dated quickly. There is a need for a report that is on-line and provides this same information in order to make educated decisions.

F. SUMMARY OF INTERVIEW WITH THE DEPUTY COMMANDER FOR CLINICAL SERVICES

The Deputy Commander for Clinical Services reports directly to the Hospital Commander on the operational function and performance of the clinics and wards.

1. Industry Factors

He is most concerned with maintaining the working level of the hospital and staff up to the bed capacity to ensure full usage of medical treatment facilities. Maintaining

the inpatient levels at or near the hospital's bed capacity ensures proper training of personnel assigned in resident programs and provides the surrounding community with adequate health-care services.

2. Competitive Strategy and Industry Position

He functions as a caretaker to report on the status of the clinics and wards throughout the hospital. He is also responsible for maintaining proper staffing levels in the clinics and wards. Although personnel are trained in specific health-care areas such as orthopedics, nursing, pharmaceutical techniques, etc., he still has the ability to move personnel around to the extent of filling gaps where needed and to provide proper training to health-care providers.

3. Environmental Factors

The only environmental factor he could point out was the nursing shortage that is affecting the hospital. This problem is well documented in previous interviews.

4. Temporal Factors

Also noted in previous interviews is the effect the PRIMUS clinics will have on the patient levels of the hospital. He described this factor as important because the PRIMUS clinics may take away business as well as refer patients in large amounts.

5. Managerial Position

He uses three reports to monitor the individual clinics within the hospital: the Nursing Report, the Officer of the Day Report, and the Administrative Officer of the Day Report. He stated that he found everything he needed in these reports to provide necessary direction to the wards and clinics.

The Nursing Report provides information about inpatients in the form of identifying the most severe cases and those cases that may have a command interest. The report is broken down by ward and provides the number of patients in each ward, the capacity of

the ward, and certain traits such as patient categories, potential discharges, and age traits. This report spans the past 24-hour period.

The Officer of the Day Report provides the number of admissions for a given 24-hour period, serious illness and deaths, command interest cases, and training accident cases. This data is used to monitor the status on patients and provide feedback to health-care administrators on selected patients.

The last report, The Administrative Officer of the Day Report, is used to provide information on such items as food services and hospital security. These items are not as critical in nature as the Officer of the Day Report, yet necessary to monitor the hospital.

6. Monitoring and Building Factors

He primarily monitors the patient satisfaction throughout the hospital and the numbers of patients in the hospital. If patient satisfaction is not adequate in a certain clinic and there is a trend developing, he takes the action necessary to set the clinic back on the right track.

G. SUMMARY OF INTERVIEW WITH THE COMMANDING OFFICER, SBHACH

The Commanding Officer of SBHACH has filled this position for at least two years. Prior to this position, he served at SBHACH in other job billets, including the Deputy Commander for Clinical Services, before stepping up as the Commanding Officer of SBHACH.

1. Industry Factors

He explained that his job was no different than the civilian counterpart to his job. He requires fast, accurate information from all parts of the hospital about the entire organization. He depends on his staff to keep him informed on any important detail that may affect the reputation of the hospital.

Two other important industry factors on which he needs information are what is happening in the department of surgery and how much unused capacity in the form of unused bed space exists daily. Every morning he conducts a morning status meeting that provides him with information on what type of surgery will be performed for that day, how it went the previous day, and the unused bed space over the past 24-hour period.

2. Competitive Strategy And Industry Position

The Commanding Officer pointed out that his major goals in this area were monitoring funding constraints and preparing for anticipated needs. He talked about how the lack of funds this year has made it difficult for the hospital to hire needed civilian health-care providers, specifically nurses. This has caused him to approach the nursing issue in a unique manner.

The resource managers at SBHACH have increased the productivity of the clinics in order to earn excess funds which can be spent on attracting civilian nurses at an increased pay rate than what they are authorized to pay now. The pay rate for civilian nurses at SBHACH is much lower than the surrounding community and it is difficult to attract good nurses to the hospital. By saving this money through increased productivity, they can now establish a salary to compete with the outside community.

He went on to point out that the hospital plans for anticipated needs due to changes in technology. They must be able to procure the necessary personnel and machinery to keep the hospital in the position of a competent provider of health-care services on the leading edge of recent medical advances.

3. Environmental Factors

He presented three environmental factors that affect the hospital: the budgetary constraints requiring the hospital to operate at a profit, fluctuating patient levels, and changes in training intensity levels at Fort Ord.

Budgetary constraints require SBHACH to operate at a profit. The hospital must provide adequate health-care services and yet not overspend its earned allotment of funds. As Chapter III describes, the method of reimbursement for health-care services provided is the Medical Care Composite Unit (MCCU). He requires an accurate approximation of what the hospital's current spending level is in order to make decisions on purchasing capital equipment and hiring civilian employees. Unfortunately, the method for reporting this information is slow, taking up to ten days at a time to provide managers with an accurate estimate of MCCUs earned to date.

The Hospital Commander explained that fluctuating patient levels affected the hospital in terms of earning MCCUs. Simply put, if patient levels drop significantly, he can expect a corresponding drop in the MCCU rate earned as well. If this level persists, he must investigate to find out why this is happening and take appropriate action if possible.

The last environmental factor presented was the effect changing levels of training intensity at Fort Ord had on the hospital. As training by ground units intensifies, the injury rate of personnel involved increases. A majority of these injuries are orthopedic in nature and require the services of skilled orthopedic personnel. To augment his orthopedic clinic, he has thought about implementing a sports physician to handle those injuries that are frequently seen from training requirements.

4. Temporal Factors

He pointed out two temporal factors affecting the administration of the hospital. He is concerned with the effects the CHAMPUS reform initiative and the PRIMUS clinics will have on the patient levels at the hospital. He has appointed a project officer to assess the impact these two variables will have on patient levels at the hospital.

The major impact of opening two clinics in the surrounding area is that they will attract some of SBHACH's clientele and reduce the MCCU earnings. But what may also

happen is that a ghost population (people who don't normally go to the hospital because it is difficult and time consuming) may fill in the void and take up some of the capacity of the PRIMUS clinics and fill in the vacated capacity at SBHACH. This situation may go either way and is a major concern of the Hospital Commander.

5. Managerial Position

In order to perform his job, he depends on his staff to provide him with accurate and timely reports. He depends on data provided by the oral morning reports, emergency room report, surgical reports, and the scrubbed data from the different MIS in the hospital.

Another key factor he monitors is the laboratory trend analysis. If the lab is finding a great deal of a certain amount of disease or sees a trend developing, the hospital staff must initiate action to determine if an outbreak or reoccurrence of a disease or epidemic is happening.

6. Internal and External Factors

SBHACH has been successful in cutting back on resources spent on supplies. The Hospital Commander asked for a 22 percent reduction across the board and the wards and clinics have complied with this request. The program to drive budget cuts was primarily an educational trend. Under his guidance, the staff educated those personnel directly involved in keeping fiscal records at the department level. In addition, personnel receive an indoctrination lesson on the goal of the hospital to reduce expenditures, increase productivity, and, as a result, earn more MCCUs.

Another external factor that was already pointed out was the nursing shortage SBHACH was experiencing. The commander watches the hiring trend closely to ensure that an appropriate nursing staff level is maintained.

7. Monitoring And Building Factors

Quality of care and productivity are the key areas he monitors. He monitors the quality of care by the number of complaints he receives from patients about a particular department. Of course there will always be complaints, but if he sees a trend developing, he takes action to find out what is happening and whether it can be corrected.

He monitors productivity by reviewing a monthly Productivity Report that matches the number of MCCUs earned by a department as compared to their optimal goal he has established. Again, if negative trends develop, he will investigate the cause and take corrective action if possible.

APPENDIX D

INTERVIEW OF MANAGEMENT INFORMATION SYSTEMS PERSONNEL

A. DESCRIPTION

This appendix summarizes several interviews conducted with personnel responsible for maintenance and upkeep of Management Information Systems (MIS) at Silas B. Hays Army Community Hospital (SBHACH). This appendix describes system details of stand-alone MIS providing information support at SBHACH. The information gained was used in determining resource usage of each MIS and to develop an understanding of what data is provided by each MIS. Names of the personnel assigned these billets have been omitted though there is nothing inappropriate in any of the interviews.

B. SUMMARY OF INTERVIEW WITH SBHACH INFORMATION MANAGEMENT DIVISION PERSONNEL

The two civilian employees working in the Information Management Division are tasked with performing maintenance on the Automated Quality of Care Evaluation Support System (AQCESS) Management Information System.

They started the interview by pointing out that the AQCESS MIS is a relatively recent addition to the hospital and, having just been implemented at the first of the year (1988), the "bugs" are still being worked out of it. The AQCESS system runs on a DEC 1184 computer and provides information to all clinics about patients and health-care providers. Each clinic is provided with a separate terminal accessing the DEC 1184 mainframe. The system provides quantitative information about the health-care services provided by health-care providers and the inpatients receiving these services at SBHACH.

The AQCESS system has three modules: Appointment Scheduling, Quality Assurance, and Patient Data. Appointment Scheduling is a decentralized appointment scheduling system that is slowly replacing the existing centralized appointment scheduling system in the hospital. They went on to explain that the appointment scheduling module allows the clinics to schedule their own appointments, schedule appointment referrals to other clinics, record appointments kept, record walk-ins, and provide print-outs to clinics regarding future and past schedules. This module offers a number of views of data and may be broken down by patient, clinic, or health-care provider over varied time periods. They also noted that statistical information is provided by this module which is helpful in determining clinic and health care provider workload levels.

Quality Assurance is used to provide profile, monitoring, and general quality assurance reports. The profile reports give specific information on health-care providers. The information provided includes education history, personal and professional credentials, and credential renewal lists. Also provided are historical listings of specific patients and medical cases the health-care provider has treated.

Monitoring reports are provided on both clinic and health-care providers. A general list of the types of health care provided, such as surgery, physical therapy, etc., is provided by clinic and identifies patients treated. Another important monitoring tool identifies by patient name if a specific health-care provider is delinquent in updating medical records.

The last reports provided by Quality Assurance are general quality assurance reports. These reports summarize important data such as blood use, patient deaths, and readmission of patients.

The third AQCESS module is Patient Data. This module provides a comprehensive record of inpatient data throughout the hospital wards. The data is a conglomeration of necessary information about inpatients and is used by the Patient Administration Division.

The AQCESS system provides both routine and ad hoc reports. Some reports are provided every 24-hour period; specifically, the clinic schedules for the next day are routinely provided to all clinics. A smaller number of reports are requested irregularly whenever specific information is required by resource managers.

C. SUMMARY OF INTERVIEW WITH RESOURCE MANAGEMENT DIVISION PERSONNEL

The two individuals interviewed are assigned to the Resource Management Division and are tasked with extracting needed information from the Uniform Chart of Accounts Performance Expense Reports (UCAPERS) Management Information System.

They explained that the purpose of the UCAPERS system was to collect and report on two Uniform Chart of Accounts data elements. The Uniform Chart of Accounts is a uniform accounting procedure established in 1979. This procedure makes all military hospital commands report on three types of accounting data in a consistent and uniform manner. The three types of data reported quarterly to higher commands are expenses, personnel usage data, and workload statistics. The UCAPERS system reports personnel expense and usage data.

The system records work performed by civilian and military health-care providers, stores this data, and submits the data to Health Services Command (HSC) in a form by which HSC can provide reimbursement of funds to SBHACH for health-care services provided.

The current system of reporting to DOD the amount of health-care services provided by the MTF is based on a unit called a Medical Care Composite Unit (MCCU). When health-care providers (doctors, nurses, lab technicians,...) provide services to patients in the form of consults, surgery, pharmaceutical prescriptions, bed space, radiology, and other varied services, the MTF is credited with MCCUs depending on the type of service.

For example, an outpatient visit is worth 0.3 MCCUs, a live birth is valued at 10 MCCUs, and admission as an inpatient is worth 10 MCCUs the first day and 1 MCCU every day there after. All health-care services provided are input daily by data-entry clerks and maintained on a computer system called UCAPERS. The information is updated daily, and weekly a tape is run summarizing all health-care services provided by the hospital. A copy of the tape is sent to a DOD-run facility where the data is calculated into MCCUs. These MCCUs are used by DOD quarterly to provide monetary funding to SBHACH in reimbursement for health-care services provided at the hospital. A hard-copy report is forwarded to the hospital one month after the quarter has expired summarizing the MCCUs earned for the previous quarter.

The system runs on Datapoint hardware connected on an Attached Resource Computer (ARC) network of microcomputers throughout the hospital.

The importance of this MIS is that it is the basis for which output in the form of health-care services provided is related to input in the form of budgetary allocation.

D. SUMMARY OF INTERVIEW WITH THE NON-COMMISSIONED OFFICER IN CHARGE OF THE PERSONNEL DIVISION

The Non-Commissioned Officer in Charge of the Personnel Division is tasked with maintaining the Standard Installation Divisional Personnel System (SIDPERS) Management Information System.

He explained that the SIDPERS MIS is a personnel information system keeping records on all assigned military personnel at the hospital. It is a personal computer system made by Burroughs that is deployable to remote sights.

SIDPERS maintains records of military personnel assigned to SBHACH on a hard disk internal to the computer. The data fields contain standard data on each soldier as well as detailed information on education, training, sex, religion, next of kin, etc., that is

necessary to the smooth function of his organization. As information on a soldier changes, or as personnel are deleted or transferred, the database is updated to reflect the correct information.

Every working day, the changes occurring over the past day are copied onto a floppy disk and hand-carried to the SIDPERS on post at Fort Ord that maintains the database post-wide.

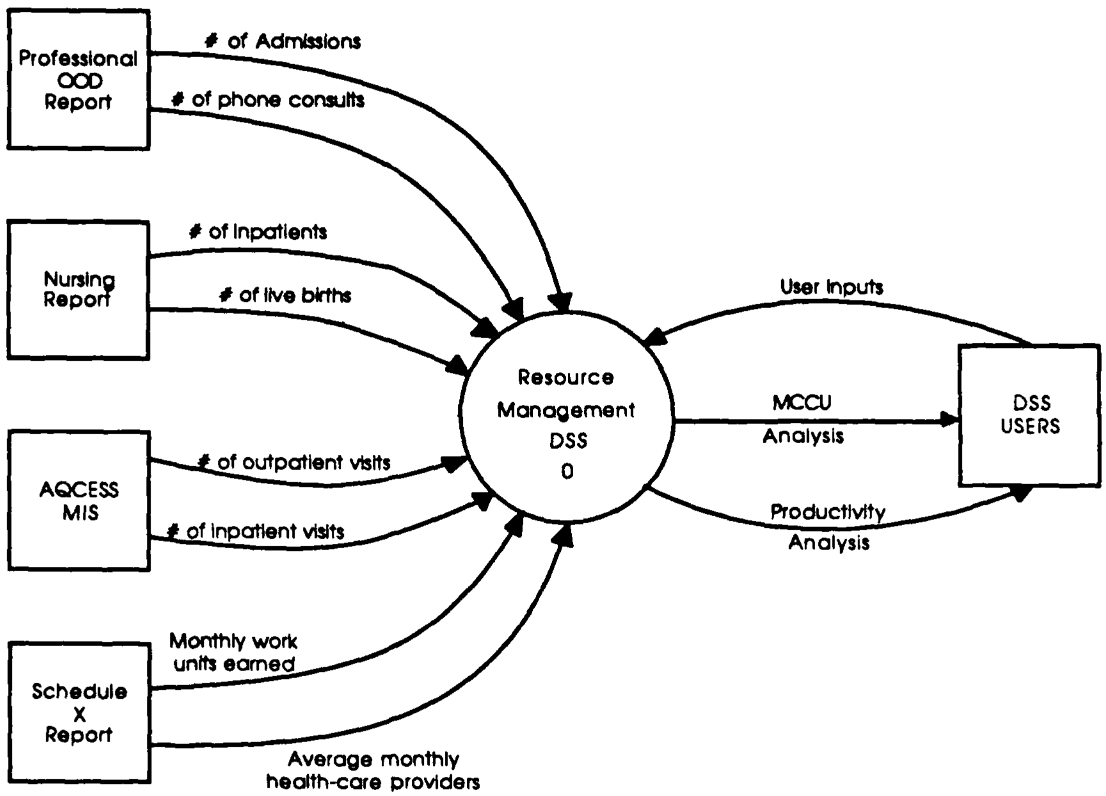
SIDPERS software allows users to view the database in different manners. It possesses the capabilities of a relational database that is menu driven to provide quick access to data that satisfies some ad hoc queries. In addition to this function, SIDPERS also provides word-processing capabilities.

He explained that although the system provides excellent relational database capabilities, it still does not satisfy all information requirements his division is tasked with providing. He explained that he cannot add data fields to the database of SIDPERS. Without this capability, he often must use SIDPERS data with other databases and manually sift through records to obtain a desired view of data. Fortunately, this is the only limitation he could point out about the SIDPERS system.

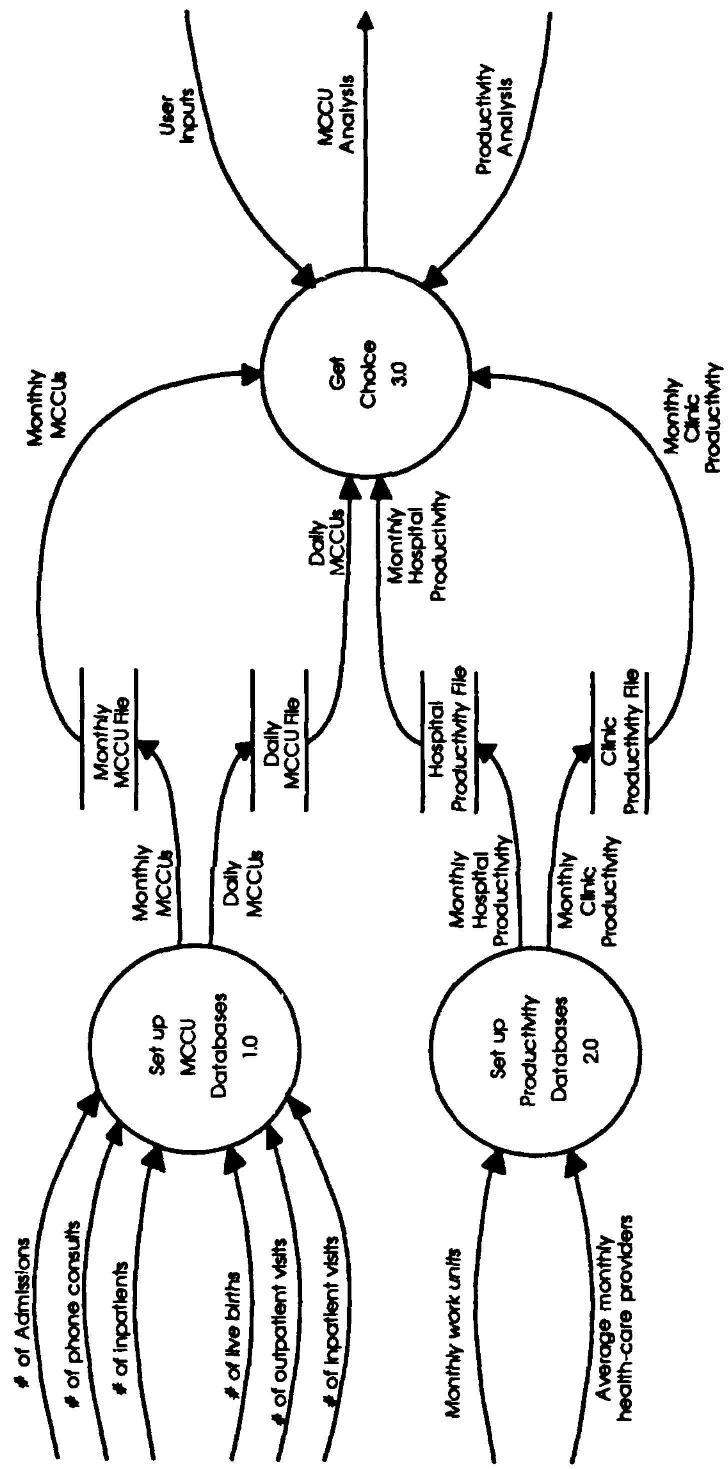
APPENDIX E

DECISION SUPPORT SYSTEM LEVELED DATA FLOW DIAGRAM

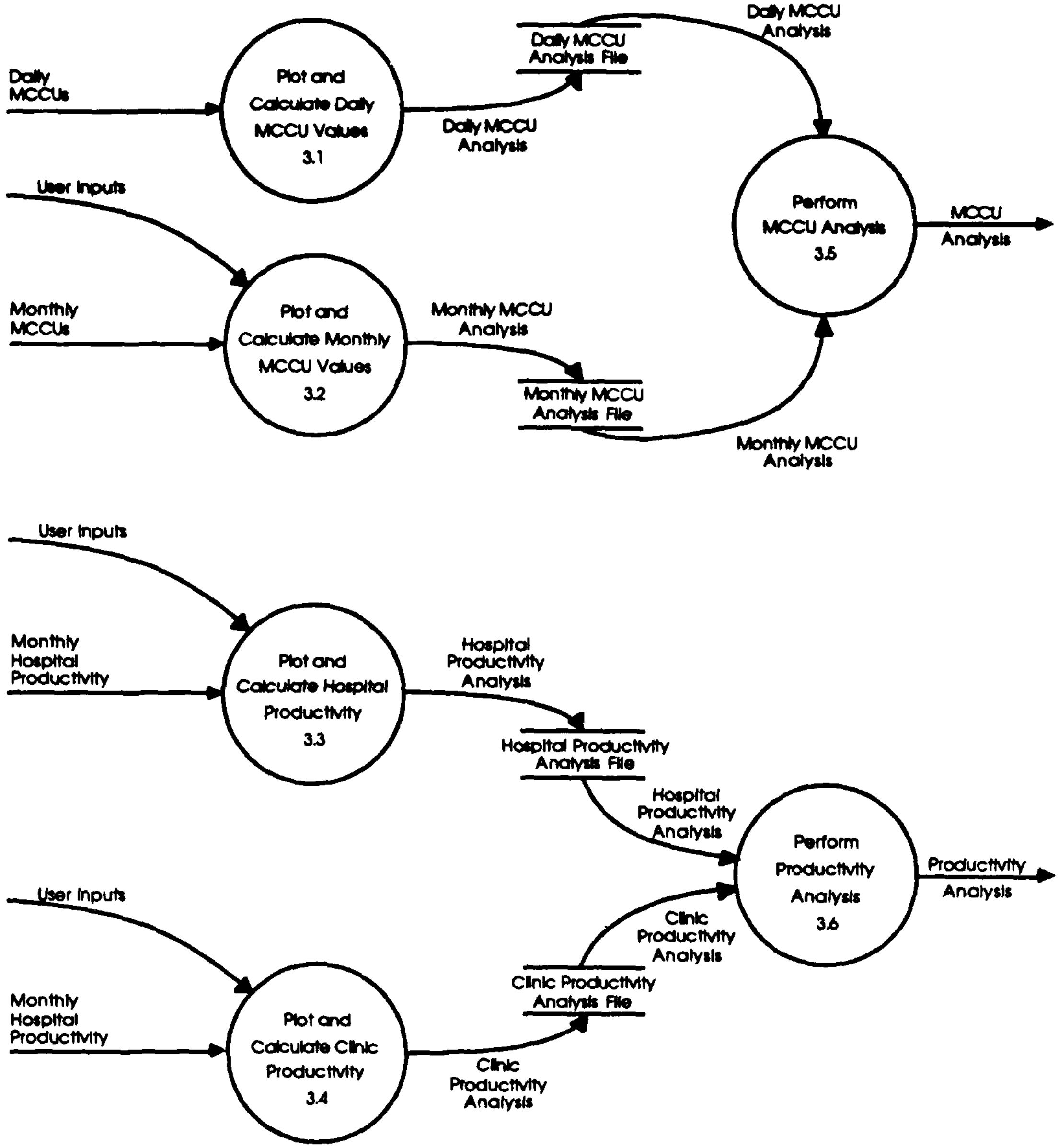
This appendix contains the leveled data flow diagram from the context diagram (level 0) and leveled to the functional primitive. Each bubble represents a process, with the lowest-level processes, functional primitives, making up the building blocks of the context diagram [Page-Jones 80]. Functional primitives cannot be further broken down into lower-level processes. Note that bubble 0 is broken down to 1.0, 2.0, and 3.0. Bubble 3.0 is then broken down to 3.1, 3.2, 3.3, etc., until further leveling is not possible.



Level 0 Data Flow Diagram Context Diagram



Level 1 Data Flow Diagram



Level 2 Data Flow Diagram

(from bubble 3.0)

APPENDIX F

DECISION SUPPORT SYSTEM MINI-SPECIFICATION

DESCRIPTION

Contained in this appendix is a statement that governs the transformation of input data flow(s) into output data flow(s) for each functional primitive in the data flow diagram.

1.0 SET UP MCCU DATABASES

For each 24-hour period at hospital, do the following:

1 Get NUMBER OF ADMISSIONS
2 Get NUMBER OF PHONE CONSULTS
3 Get NUMBER OF INPATIENTS
4 Get NUMBER OF LIVE BIRTHS
5 Get NUMBER OF OUTPATIENT VISITS
6 Get NUMBER OF INPATIENT VISITS
7 Calculate DAILY MCCUS by:
   7.1 (NUMBER OF ADMISSIONS x ADMISSION VALUE) +
   7.2 (NUMBER OF PHONE CONSULTS x PHONE VALUE) +
   7.3 [(NUMBER OF INPATIENTS - NUMBER OF ADMISSIONS) x INPATIENT VALUE] +
   7.4 (NUMBER OF LIVE BIRTHS x BIRTH VALUE) +
   7.5 [(NUMBER OF INPATIENT VISITS + NUMBER OF OUTPATIENT VISITS) x VISIT VALUE]
8 Put DAILY MCCUS in DAILY MCCU FILE

If end of month then

9 Get DAILY MCCUS
10 Calculate MONTHLY MCCUS
11 Put MONTHLY MCCUS in MONTHLY MCCU FILE

2.0 SET UP PRODUCTIVITY DATABASES

For each clinic do the following:

1 Get MONTHLY WORK UNITS

2 Get AVERAGE MONTHLY HEALTH CARE PROVIDERS

3 Calculate MONTHLY CLINIC PRODUCTIVITY by:

   3.1 MONTHLY WORK UNITS / AVERAGE MONTHLY HEALTH-CARE PROVIDERS

4 Put MONTHLY CLINIC PRODUCTIVITY in CLINIC PRODUCTIVITY FILE

For the hospital do the following:

5 Calculate MONTHLY HOSPITAL PRODUCTIVITY

6 Put MONTHLY HOSPITAL PRODUCTIVITY in HOSPITAL PRODUCTIVITY FILE

3.1 PLOT AND CALCULATE DAILY MCCU VALUES

If choice is display MCCU earnings to date then:

1 Get DAILY MCCUS

2 Calculate MCCUS earned to date

3 Display MCCUS earned to date

Else choice is graph most recent 30 days worth of DAILY MCCUS

4 Get DAILY MCCUS

5 Graph DAILY MCCUS

3.2 PLOT AND CALCULATE MONTHLY MCCU VALUES

If choice graph current years monthly MCCUs then

1 Get MONTHLY MCCUS

2 Graph MONTHLY MCCUS

Else if choice graph previous years monthly MCCUs then

3 Get MONTHLY MCCUS

4 Graph MONTHLY MCCUS

Else if choice make predictions based on historical data then

5 Get number of months to be predicted

6 Get number of months to base forecast

7 Get MONTHLY MCCUS

8 Forecast months

9 Display forecasted months

9.1 If one month then

9.2 Display

9.3 Else more than one month then

9.4 Graph

Else choice is make predictions based on user predicted inputs

10 Get number of months to be predicted

11 Get number of historical months to base forecast

12 Get MONTHLY MCCUS

13 Get future months values

14 Forecast months

15 Graph forecasted months

3.3 PLOT AND CALCULATE HOSPITAL PRODUCTIVITY

If choice graph any six-month period hospital productivity then

1 Get six-month period

2 Get MONTHLY HOSPITAL PRODUCTIVITY

3 Graph six-month period

Else if choice make predictions based on historical data then

4 Get number months to be predicted

5 Get number of historical months to base forecast

6 Get MONTHLY HOSPITAL PRODUCTIVITY

7 Forecast months

8 Graph forecasted months

Else choice is make predictions based on user-predicted inputs

9 Get number of months to be predicted

10 Get number of historical months to base forecast

11 Get MONTHLY HOSPITAL PRODUCTIVITY

12 Get future months values

13 Forecast months

14 Graph forecasted months

3.4 PLOT AND CALCULATE CLINIC PRODUCTIVITY

If choice graph any clinic six-month period productivity then

1 Get clinic name

2 Get six-month period

3 Get MONTHLY CLINIC PRODUCTIVITY

4 Graph six-month period

Else if choice make predictions based on historical data then

5 Get clinic name

6 Get number months to be predicted

7 Get number of historical months to base forecast

8 Get MONTHLY CLINIC PRODUCTIVITY

9 Forecast months

10 Graph forecasted months

Else choice is make predictions based on user-predicted inputs

11 Get clinic name

12 Get number of months to be predicted

13 Get number of historical months to base forecast

14 Get MONTHLY CLINIC PRODUCTIVITY

15 Get future months values

16 Forecast months

17 Graph forecasted months

3.5 PERFORM MCCU ANALYSIS

1 Present MCCU menu choice

2 Get MCCU menu choice

3 Present MCCU ANALYSIS

3.6 PERFORM PRODUCTIVITY ANALYSIS

1 Present productivity menu choice

2 Get productivity menu choice

3 Present PRODUCTIVITY ANALYSIS

APPENDIX G

DECISION SUPPORT SYSTEM DATA DICTIONARY

DESCRIPTION

This appendix contains definitions of data elements found in the data flow diagram and referenced in the mini-specification. The term or meaning of each data element may be found here.

ADMISSION VALUE = 10.0 *the value earned for admitting a patient into the hospital*

AVERAGE HEALTH-CARE PROVIDERS = *the average number of health-care providers present in a clinic for the month*

AVERAGE MONTHLY HEALTH-CARE PROVIDERS = CLINIC NAME + AVERAGE HEALTH-CARE PROVIDERS

BIRTH VALUE = 10.0 *the value earned for a live birth in the hospital*

CLINIC PRODUCTIVITY FILE = {CLINIC NAME + MONTH + YEAR + PRODUCTIVITY} *file contains all clinical monthly productivity values for the past 24-month period*

DAILY MCCUS = DATE + MCCUS

DAILY MCCU FILE = {DATE + MCCUS} *file contains the current fiscal year's daily MCCU earnings and has at least 30 days of data and no more than 365 days*

DATE = YEAR + MONTH + DAY

HOSPITAL PRODUCTIVITY FILE = {MONTH + YEAR + PRODUCTIVITY} *file contains the hospital's past 24 months' worth of productivity*

INPATIENT VALUE = 1.0 *the value earned for each inpatient in the hospital each day*

MCCUS = *a value that equates to the amount of health services rendered by the hospital over a specified period of time*

MCCU ANALYSIS = *any type of data in any format provided about either monthly or daily MCCUs earned in the past or projected in the future*

MONTHLY CLINIC PRODUCTIVITY = CLINIC NAME + MONTH + YEAR + PRODUCTIVITY

MONTHLY HOSPITAL PRODUCTIVITY = MONTH + YEAR + {PRODUCTIVITY} *file contains the past 24 months of hospital productivity*

MONTHLY MCCUS = MONTH + YEAR + MCCUS

MONTHLY MCCU FILE = {MONTH + MCCUS} *file contains the previous year's 12 months' worth of MCCU data and the current month's MCCU data so far*

MONTHLY WORK UNITS = CLINIC NAME + MONTH + WORK UNITS *the number of work units earned by each clinic on a monthly basis*

NUMBER OF ADMISSIONS = *admissions the past 24-hour period*

NUMBER OF INPATIENTS = *census of the total number of inpatients past 24-hour period, census taken at a specific time each 24-hour period*

NUMBER OF INPATIENT VISITS = *total number of inpatients that visited clinics in the past 24-hour period*

NUMBER OF LIVE BIRTHS = *total number of live births occurring in the past 24-hour period*

NUMBER OF OUTPATIENT VISITS = *total number of outpatients that visited clinics in the past 24-hour period*

NUMBER OF PHONE CONSULTS = *total number of patients that were treated over the phone by health-care providers in the past 24-hour period*

PHONE VALUE = 0.3 *the value earned for a phone consult to a patient*

PRODUCTIVITY = *for each clinic based on work units earned each month divided by average monthly health-care providers assigned*

PRODUCTIVITY ANALYSIS = *any type of data in any format provided about either hospital monthly productivity or clinic monthly productivity*

VISIT VALUE = 1.0 *the value earned for a visit to a clinic by an inpatient or outpatient*

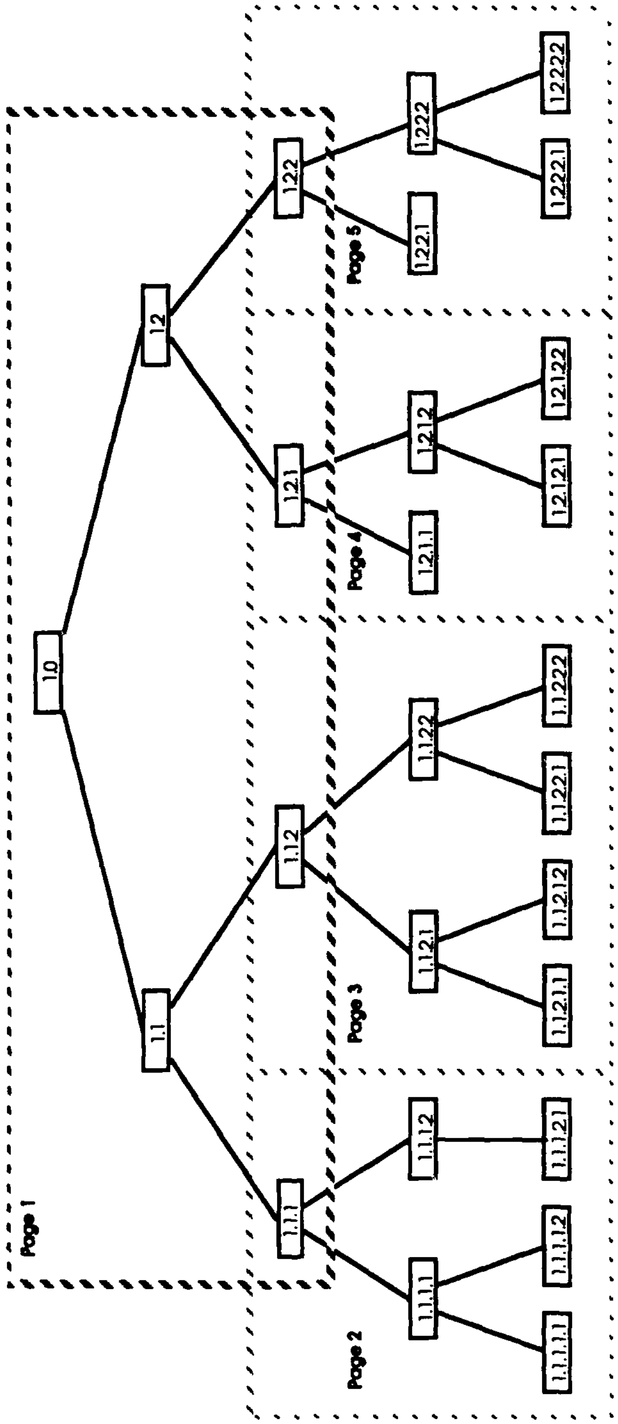
WORK UNITS = *a value that equates to the services rendered by a clinic to inpatients and outpatients over a one-month period*

APPENDIX H

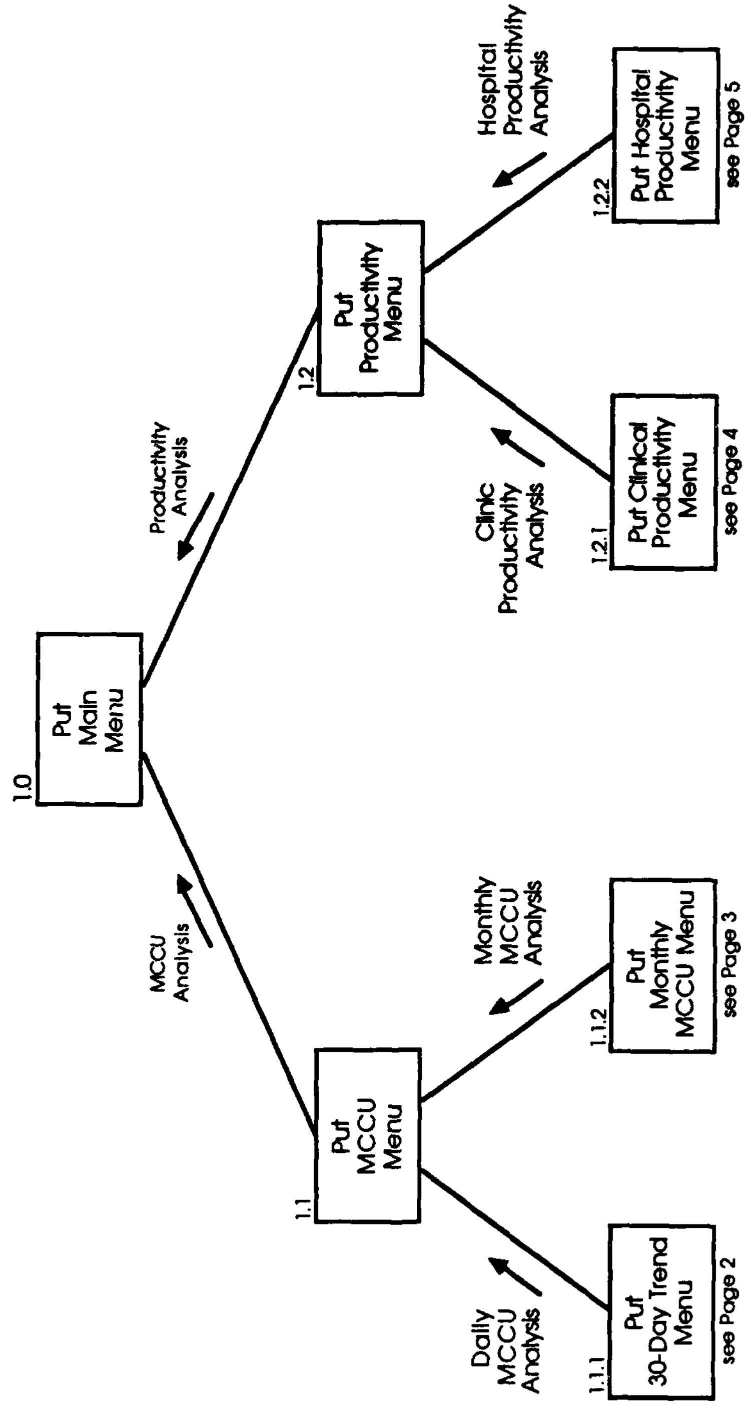
DECISION SUPPORT SYSTEM STRUCTURE CHART

DESCRIPTION

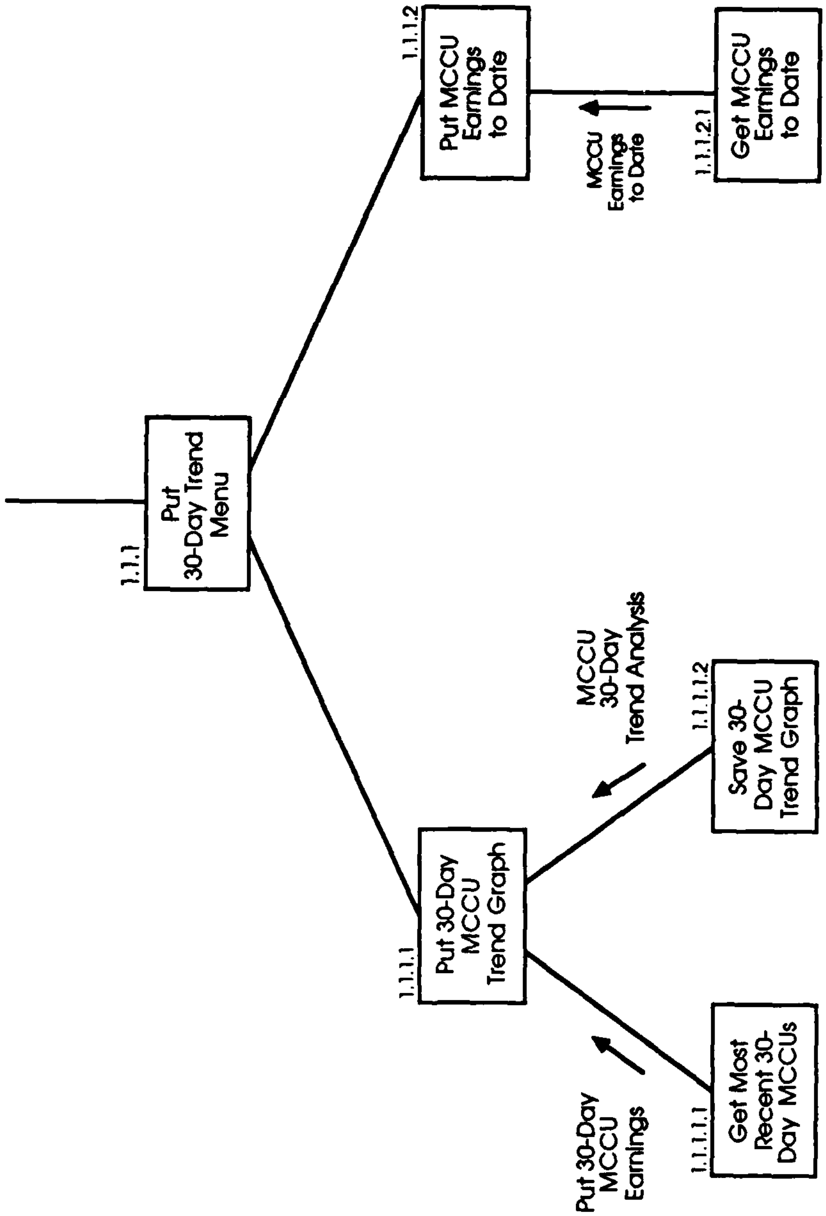
This appendix contains the transformed data flow diagram in structure chart form. Data elements are shown passing between individual modules. Level 0, the context diagram, shows the entire structure chart on one page. It is important to show the morphology of the system because poorly structured systems can be identified by the downward flow of modules alone [Page-Jones 80].



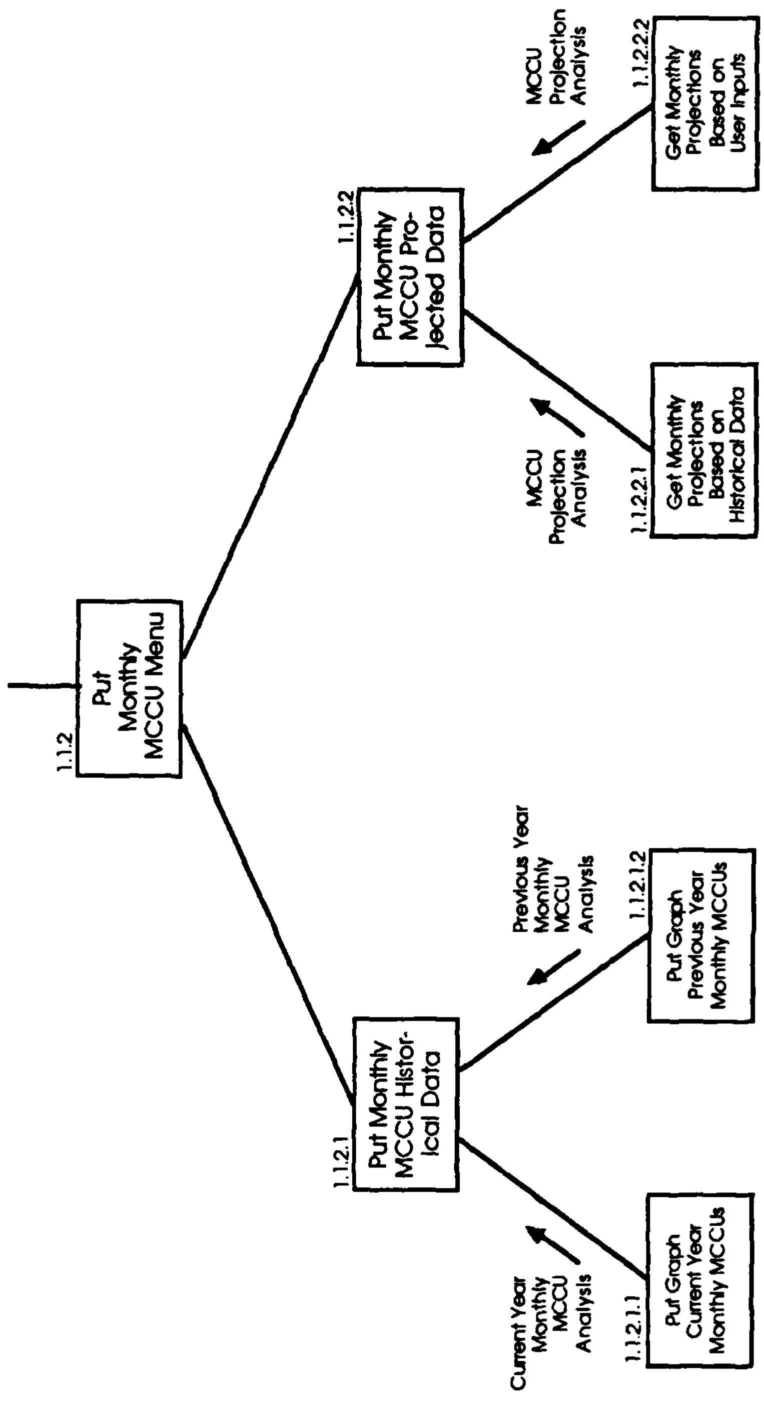
Context Diagram
(level 0)


1.0
Put Main Menu
MCCU Analysis
Productivity Analysis
1.1
Put MCCU Menu
1.2
Put Productivity Menu
Daily MCCU Analysis
Monthly MCCU Analysis
Clinic Productivity Analysis
Hospital Productivity Analysis
1.1.1
Put 30-Day Trend Menu
see Page 2
1.1.2
Put Monthly MCCU Menu
see Page 3
1.2.1
Put Clinical Productivity Menu
see Page 4
1.2.2
Put Hospital Productivity Menu
see Page 5

Page 1

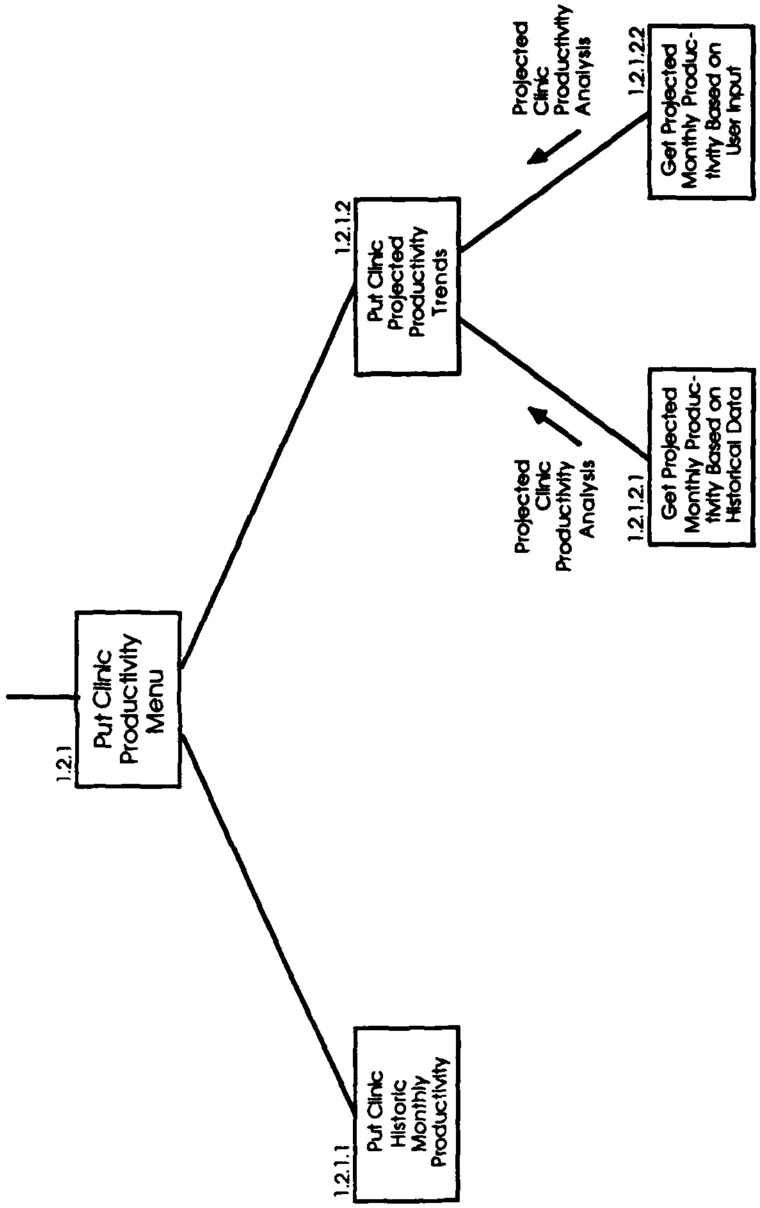

1.1.1
Put 30-Day Trend Menu
1.1.1.1
Put 30-Day MCCU Trend Graph
1.1.1.2
Put MCCU Earnings to Date
1.1.1.1.1
Get Most Recent 30-Day MCCUs
1.1.1.1.2
Save 30-Day MCCU Trend Graph
1.1.1.2.1
Get MCCU Earnings to Date
Put 30-Day MCCU Earnings
MCCU 30-Day Trend Analysis
MCCU Earnings to Date

Page 2



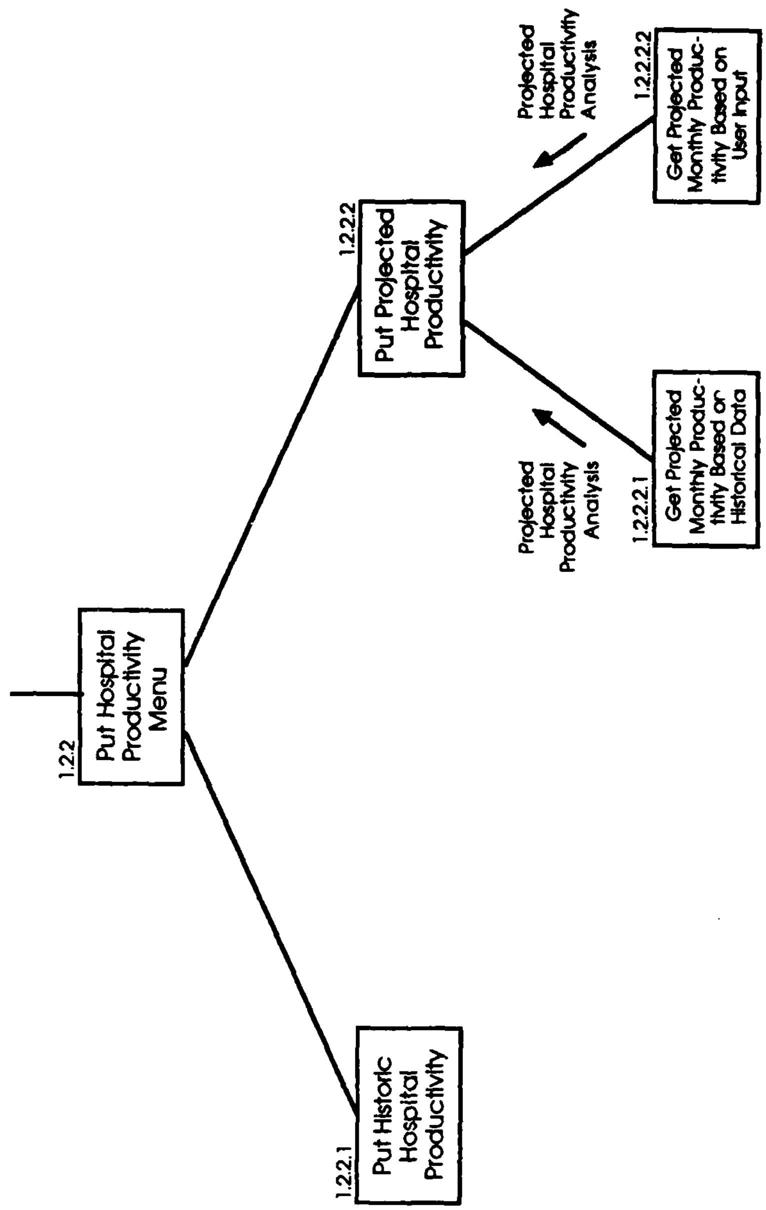
1.1.2
Put Monthly MCCU Menu
1.1.2.1
Put Monthly MCCU Historical Data
1.1.2.2
Put Monthly MCCU Projected Data
Current Year Monthly MCCU Analysis
1.1.2.1.1
Put Graph Current Year Monthly MCCUs
Previous Year Monthly MCCU Analysis
1.1.2.1.2
Put Graph Previous Year Monthly MCCUs
MCCU Projection Analysis
1.1.2.2.1
Get Monthly Projections Based on Historical Data
MCCU Projection Analysis
1.1.2.2.2
Get Monthly Projections Based on User Inputs

Page 3



1.2.1
Put Clinic Productivity Menu
1.2.1.1
Put Clinic Historic Monthly Productivity
1.2.1.2
Put Clinic Projected Productivity Trends
1.2.1.2.1
Get Projected Monthly Productivity Based on Historical Data
Projected Clinic Productivity Analysis
1.2.1.2.2
Get Projected Monthly Productivity Based on User Input
Projected Clinic Productivity Analysis

Page 4


1.2.2
Put Hospital Productivity Menu
1.2.2.1
Put Historic Hospital Productivity
1.2.2.2
Put Projected Hospital Productivity
1.2.2.2.1
Get Projected Monthly Productivity Based on Historical Data
1.2.2.2.2
Get Projected Monthly Productivity Based on User Input
Projected Hospital Productivity Analysis
Projected Hospital Productivity Analysis

Page 5

APPENDIX I

DECISION SUPPORT SYSTEM MODULE SPECIFICATIONS

DESCRIPTION

This appendix contains the specification of the major modules in the structure chart written in pseudocode. This specification in pseudocode follows the technique of Page-Jones [Page-Jones 80]. The module specification gives a more precise description of the graphical presentation found in the structure chart. This textual description gives guidance to the programmer in order to derive source code from system documentation [Page-Jones 80].

```
MODULE      PUT MAIN MENU
    /*Finds what user wishes to look at, MCCUs or productivity analysis*/
    /*Checks choice for validity*/

        Put menu choices
        Get valid choice
            If not quit then
                If request for MCCUs then call module to display MCCU menu
                Else if request for productivity then call module to display
                    productivity menu
End module


MODULE      PUT MCCU MENU
    /*Finds what user wishes to look at, thirty-day MCCU trends or monthly
        MCCUs*/
    /*Checks choice for validity*/

        Put menu choices
        Get valid choice
```

If not quit then

If request for thirty-day MCCU trends then call module to display thirty-day MCCU menu

Else if request for monthly MCCU data then call module to display monthly MCCU menu

End module

MODULE PUT THIRTY-DAY TREND MENU

/*Finds what user wishes to look at, the most recent thirty-day MCCU trend or MCCU earnings to date*/

/*Validates choice*/

Put menu choice

Get valid choice

If not quit then

If request for most recent thirty-day trends then call module to present thirty-day graph (see Figure I-1)

Else if request for MCCU earnings to date then call module to put MCCU earnings to date

End module

MODULE PUT THIRTY-DAY MCCU TREND GRAPH

/*Gets the most recent thirty days worth of daily MCCU earnings and graphs it*/

/*Daily MCCUs on the vertical axis*/

/*Past thirty days on the horizontal axis*/

Call module to get most recent thirty days worth of data

Graph data (see Figure I-1)

End module

```
MODULE       PUT MCCU EARNINGS TO DATE
        /*Gets the total MCCU earnings for the current fiscal year*/
        /*Totals MCCU earnings and puts MCCU earnings to date*/

                Call module to get current year's daily MCCUs
                Total daily MCCU earnings to date
                Put MCCU earnings to date
End module


MODULE       PUT MONTHLY MCCU MENU
        /*Finds what the user wishes to look at, historical or projected data*/
        /*Checks choice for validity*/

                Put menu choice
                Get valid choice
                        If not quit then
                            If request for historic data, then call module to display graph of
                                historic data
                            Else if request for projected data, then call module to display
                                graph of projected data
End module


MODULE       PUT MONTHLY MCCU HISTORIC DATA
        /*Depending on user request, graph monthly MCCUs current year's data or graph
            previous year's monthly MCCU data*/
        /*Validates choice*/

                Put menu choice
                Get valid choice
                      If not quit then
                            If request for current year's monthly MCCUs then
                                Call module to get current year's monthly MCCU data
```

```
                    Call module to graph data (see Figure I-2)
                Else if request for previous year monthly MCCUs then
                    Call module to get past 12 months of data
                    Call module to graph data (see Figure I-2)
End module


MODULE      PUT MONTHLY MCCU PROJECTED DATA
    /*Depending on the users choice, forecast monthly MCCU earnings based on
        historic data or user input predictions*/
    /*Validates choice*/

        Put menu choice
        Get valid choice
            If not quit then
                If request for projections based on historic data then
                    Get number of months to be projected from user
                    Get number of months of historic data to base projection
                        on from user
                    Call module to get historic data
                    Call module to calculate projections
                    Call module to graph data (see Figure I-2)
                Else if request for projections based on user input then
                    Get number of months to be projected from user
                    Get number of future months to be input by user
                    Get user input of future months
                    Call module to get historic data
                    Call module to calculate projections
                    Call module to graph data (see Figure I-2)
End module
```

```
MODULE    PUT PRODUCTIVITY MENU
    /*Gives user a choice between clinic or hospital productivity*/
    /*validate choice*/

        Put menu choice
        Get valid choice
            If not quit then
                If request for clinical productivity then call module to display
                    clinical productivity menu choice
                Else if request for hospital productivity then call module to
                    display hospital productivity menu choice
End module

MODULE    PUT CLINICAL PRODUCTIVITY
    /*Gets choice of historic data or projected data*/
    /*Validates choice*/

        Put menu choice
        Get valid choice
            If not quit then
                If request for historic clinic productivity then
                    Get name of clinic from user
                    Get months to be graphed from user
                    Validate months requested
                    Call module to get data
                    Call module to graph data (see Figure I-3)
                Else if request for projected clinic productivity then
                    Call module to display clinic projected productivity trends
End module
```

```
MODULE     PUT CLINIC PROJECTED PRODUCTIVITY TRENDS
     /*Gets user's choice to forecast monthly clinic productivity based on historic data
          or user input data*/
     /*Validates choice*/

          Put menu choice
          Get valid choice
               If not quit then
                    If request for projections based on historic data then
                         Get clinic name from user
                         Get number of months to be projected from user
                         Get number of months of historic data to base projection
                              on from user
                         Call module to get historic data
                         Call module to calculate projections
                         Call module to graph data (see Figure I-3)
                    Else if request for projections based on user input then
                         Get clinic name from user
                         Get number of months to be projected from user
                         Get number of future months to be input by user
                         Get user input of future months
                         Call module to get historic data
                         Call module to calculate projections
                         Call module to graph data (see Figure I-3)
End module

MODULE     PUT HOSPITAL PRODUCTIVITY MENU
     /*Gets choice of historic data or projected data*/
     /*Validates choice*/

          Put menu choice
          Get valid choice
               If not quit then
```

```
                If request for historic hospital productivity then
                    Get months to be graphed from user
                    Validate months requested
                    Call module to get data
                    Call module to graph data (see Figure I-3)
                Else if request for projected hospital productivity then
                    Call module to display projected hospital productivity
End module

MODULE      PUT PROJECTED HOSPITAL PRODUCTIVITY
    /*Gets user's choice to forecast monthly hospital productivity based on historic
        data or user input data*/
    /*Validates choice*/

        Put menu choice
        Get valid choice
            If not quit then
                If request for projections based on historic data then
                    Get number of months to be projected from user
                    Get number of months of historic data to base projection
                        on from user
                    Call module to get historic data
                    Call module to calculate projections
                    Call module to graph data (see Figure I-3)
                Else if request for projections based on user input then
                    Get number of months to be projected from user
                    Get number of future months to be input by user
                    Get user input of future months
                    Call module to get historic data
                    Call module to calculate projections
                    Call module to graph data (see Figure I-3)
End module
```

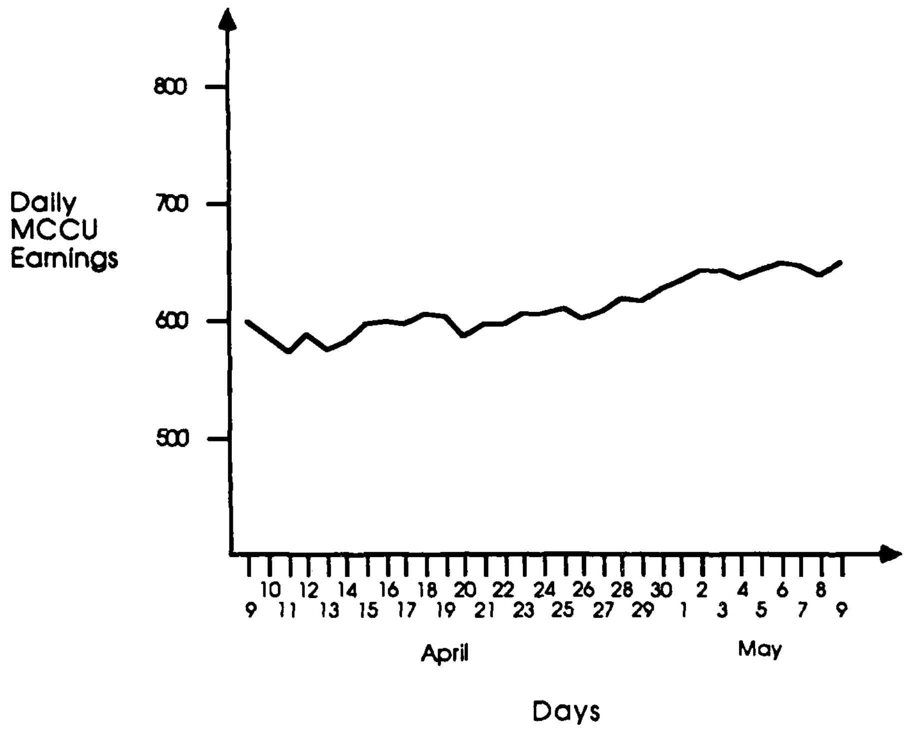


Figure I-1. **Sample 30-Day MCCU Graph**

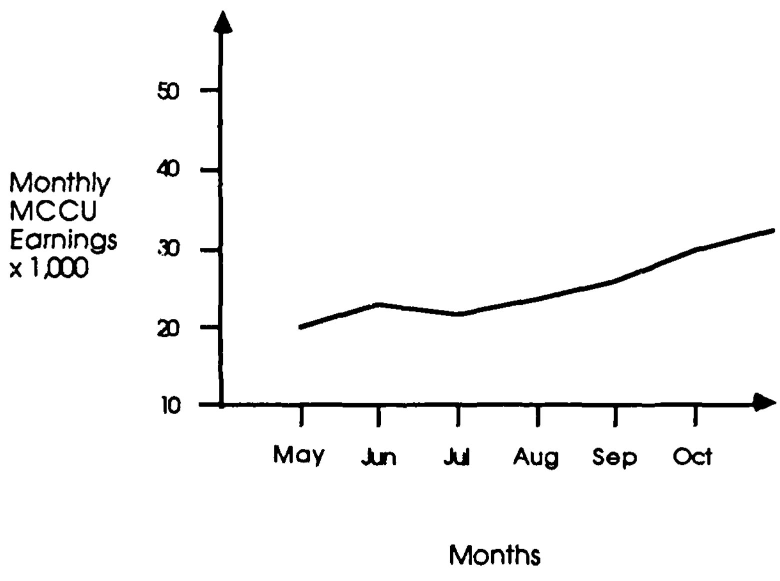


Figure I-2. **Sample MCCU Monthly Earnings Graph**

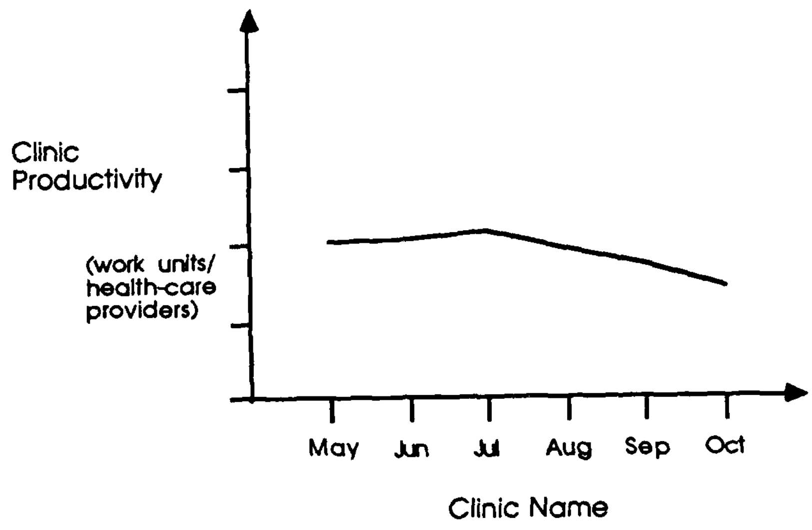


Figure I-3. **Sample Clinical Productivity Graph**

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